

**Work Plan**

**Sediment and Groundwater Monitoring**

**for**

**Old Fire Fighting Training Area**  
**Naval Station Newport**  
**Newport, Rhode Island**



948

**Engineering Field Activity Northeast**  
**Naval Facilities Engineering Command**  
**Contract Number N62467-94-D-0888**  
**Contract Task Order 0833**

**November 2004**



**TETRA TECH NUS, INC.**



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C-NAVY-06-04-1720W

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June 30, 2004

Project Number N4152

Mr. Curtis Frye  
Remedial Project Manager  
EFA Northeast, Naval Facilities Engineering Command  
10 Industrial Highway, Mail Stop 82  
Lester, Pennsylvania 19113

Reference: CLEAN Contract No. N62467-94-D-0888  
Contract Task Order No. 0833

Subject: Transmittal of Draft Work Plan for Sediment and Groundwater Monitoring  
Old Fire Fighting Training Area  
Naval Station Newport, Newport, Rhode Island

Dear Mr. Frye:

Enclosed per your request, you will find 4 copies of the draft sediment and groundwater monitoring work plan for the site referenced above. This work plan has been prepared to direct limited, short term sampling activities at the site prior to and during the soil removal actions upcoming this year. Additional work plans will be prepared to describe long term monitoring of the sediment after the removal actions are completed.

In accordance with the scope of work, additional copies of this work plan have been provided to the recipients on the distribution list below for their review and comment.

If you have any questions regarding this material, please do not hesitate to contact myself or Jim Forrelli.

Very truly yours,

Stephen S. Parker, LSP  
Project Manager

SSP/rp

Enclosures

- c: K. Keckler, USEPA (w/encl. - 4)  
P. Kulpa, RIDEM (w/encl. - 4)  
S. McFadden, TAG (w/encl. - 1)  
C. Mueller, NAVSTA (w/encl. - 2)  
NAVSTA RAB (c/o Kathy Marley w/ encl. - 4 Electronic)  
NAVSTA Repositories (c/o Kathy Marley w/encl. - 4 Electronic)  
J. Stump, Gannett Fleming (w/encl. 2)  
J. Trepanowski/G. Glenn, TtNUS (w/ encl.)  
File N4152-3.2 w/o encl., N4152-8.0 (w/encl.)



**WORK PLAN**  
**SEDIMENT AND GROUNDWATER MONITORING**  
**FOR**  
**OLD FIRE FIGHTING TRAINING AREA**  
**NAVAL STATION NEWPORT**  
**NEWPORT, RHODE ISLAND**  
**COMPREHENSIVE LONG-TERM**  
**ENVIRONMENTAL ACTION - NAVY (CLEAN) CONTRACT**

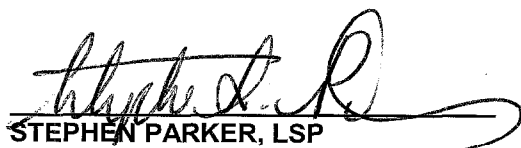
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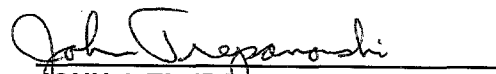
**Contract Number N62467-94-D-0888**  
**Contract Task Order 0833**

**JUNE 2004**

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- A Standard Operating Procedures
- B Field Documentation Forms

## LIST OF ACRONYMS

AAL	Rhode Island Ambient Air Limit
ACOE	U.S. Army Corps of Engineers
ARAR	Applicable or Relevant and Appropriate Requirement
AVS	Acid Volatile Sulfides
AWQC	Ambient Water Quality Criteria
B&RE	Brown & Root Environmental
CAD	Contained Aquatic Disposal
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of Concern
CT	Central Tendency
DAF	Dissolved Air Flotation
EPA	U.S. Environmental Protection Agency
ERA	Marine Ecological Risk Assessment
ER-L	Effects Range-Low: NOAA Adverse Effects Benchmark Value For Sediment
ER-M	Effects Range-Median: NOAA Adverse Effects Benchmark Value For Sediment
FFA	Federal Facilities Interagency Agreement
FS	Feasibility Study
FWENC	Foster Wheeler Environmental Corporation
GRA	General Response Action
HHRA	Human Health Risk Assessment
HI	Hazard Index Ratio
IAS	Initial Assessment Study
IEUBK	Integrated Exposure and Uptake Biokinetic Model
IRP	Installation Restoration Program
IU/BK	Integrated Uptake/Biokinetic Model
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mg/l	milligram per liter
MLW	Mean Low Water Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NETC	Naval Education and Training Center
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NORTHDIV	Northern Division
NPL	National Priorities List

## LIST OF ACRONYMS (Continued)

NS	Nearshore
O&M	Operation and Maintenance
OS	Offshore
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PDI	Pre-Design Investigation
POTW	Publicly-Owned Treatment Works
PPE	Personnel Protective Equipment
PRG	Preliminary Remedial Goal
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RfD	Risk Reference Dose
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SAIC	Science Applications International Corporation
SARA	Superfund Amendment and Reauthorization Act
SEM	Simultaneously Extracted Metals
SER	Shore Establishment Realignment Program
SIM	Selected Ion Monitoring
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TBC	To Be Considered Guidance
TCL	Target Compound List
TCLP	Toxic Characteristic Leaching Procedure
TCR	Tissue Concentration Ratio
TEV-HQ	Threshold Effects Value - Hazard Quotient
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRC	TRC Environmental Corporation
TSDF	Treatment, Storage, and Disposal Facility
TSS	Total Suspended Solids

**LIST OF ACRONYMS (Continued)**

TWA	Time-Weighted Average Concentration
µg/dl	microgram per deciliter
µg/kg	microgram per kilogram
µg/l	microgram per liter
URI	University of Rhode Island
VOC	Volatile Organic Compound

## **1.0 INTRODUCTION**

This work plan has been prepared to provide the sampling and analysis program proposed for Contract Task Order (CTO) 833, under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62467-94-D-0888. Pursuant to the CTO, Tetra Tech NUS, Inc. will execute the scope of work to perform monitoring of groundwater and marine sediments at the Old Fire Fighting Training Area (OFFTA), which is part of the Naval Station Newport (NSN), in Newport, Rhode Island.

### **1.1 SCOPE AND OBJECTIVE**

The monitoring effort is being implemented to continue to evaluate groundwater, sediment, and eelgrass conditions at the site. The groundwater data from this effort will be used to document the condition of the groundwater prior to initiation of soil removal actions in 2004. Sediment data from this investigation will be used to verify that no further degradation of the sediment has occurred as a result of the first phase of soil removal actions. In addition, sediment data will be used to support previous findings that existing sediment contamination is not only site-related, but also a result of urban (non-site related) inputs from onshore (i.e. storm water sewers) and offshore (ambient bay concentrations). Data from this monitoring effort will be compared to prior groundwater and sediment data collected for the Remedial Investigation and during the predesign investigations conducted between 2001 and 2003. Finally, the monitoring effort will also verify that the sensitive environments in this area are not impacted by the first phase of the soil removal actions and that evidence of good ecological health remains through evaluation of eelgrass beds.

This work plan only addresses groundwater monitoring prior to and sediment monitoring after completion of the first phase of the soil removal actions planned at the site. It is currently anticipated that one round of groundwater and one round of sediment samples will be collected under this work plan, although additional data collection efforts may be conducted as needed to meet the objectives of the work plan. Following completion of the soil removal action, an interim or long-term monitoring program will be initiated to evaluate changing conditions over time. The long term program will be described in a separate work plan.

This Draft Work Plan includes four sections: this Introduction; the Site Background, including a brief summary of existing data and the sampling and analysis program design; the Field Sampling Plan; and the Quality Assurance/Quality Control Plan. Appendix A presents Standard Operating Procedures (SOPs) for the field investigation work. Appendix B contains samples of forms to be used for documentation during this investigation.



The tasks described in this Draft Work Plan include:

- Collection of surface sediment samples in and around previously identified "hot spots" of PAH and metals contaminants.
- Analysis of sediment samples to compare to previous sediment sampling results.
- Analysis of sediment samples using forensic techniques to confirm various contaminant sources.
- Mapping of the extent of the eelgrass present during peak season.
- Collection of groundwater samples at existing groundwater monitoring wells.
- Analysis of groundwater samples for PAHs, VOCs, and metals to determine whether further degradation of the groundwater is taking place and if concentrations exceed PRGs for groundwater.
- Preparation and submittal of draft and final reports describing the findings of these investigations.

## 2.0 BACKGROUND INFORMATION

This section presents background information for the OFFTA site, including a site description, site history, a brief summary of previous investigations, a summary of the sampling and analysis program design, and a discussion of the project data quality objectives.

### 2.1 SITE LOCATION AND DESCRIPTION

The NSN is located approximately 60 miles southwest of Boston, Massachusetts, and 25 miles south of Providence, Rhode Island. It occupies approximately 1,063 acres, with portions of the facility located in the City of Newport and Towns of Middletown and Portsmouth, Rhode Island. The facility layout is long and narrow, following the western shoreline of Aquidneck Island for nearly 6 miles facing the east passage of Narragansett Bay.

#### 2.1.1 Site Conditions

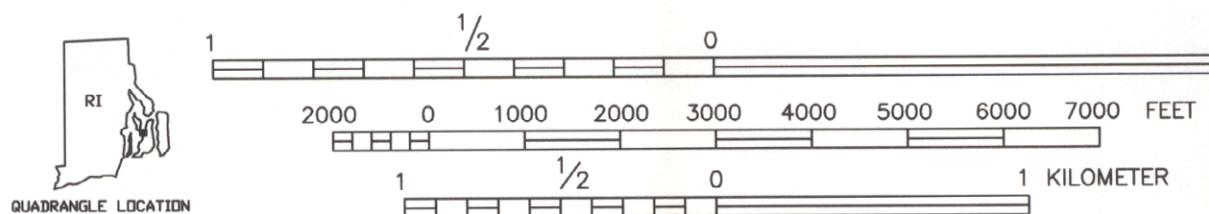
The OFFTA site is located at the northern end of Coasters Harbor Island (see Figure 2-1). The site occupies approximately 5.5 acres and is bordered by Taylor Drive to the south and is surrounded by Coasters Harbor (part of Narragansett Bay) to the east, north, and west. The site currently is fenced, and is covered by mown grass and a temporary parking lot. A one-story concrete block building (Building 144) is located along the southern side of the site, which is used by the U.S. Army and U.S. Marine Corps recruiting offices.

Unique topographic features at the site include three soil mounds: one that is approximately 20 feet high (30 feet above mean low water) located in the center of the site, another that is approximately 6 feet high (16 feet above mean low water) located on the western side of the site, and a third smaller mound at the far west end of the site. These mounds are believed to be made up of rubble from demolition of the fire training school structures. The rest of the OFFTA site is generally flat, with surface elevations ranging from 8 to 12 feet above mean low water. A site plan is presented as Figure 2-2.

#### 2.1.2 Marine Habitats

The marine habitat discussion presented in this section is based on data collected during the marine Ecological Risk Assessment (ERA) for the OFFTA. Refer to the Ecological Risk Assessment Report (SAIC, 2000) for complete details.





## SITE LOCUS

## FIGURE 2-1

WORKPLAN FOR SEDIMENT AND GROUNDWATER MODELING

OFFTA, SITE 09, NAVSTA - NEWPORT, RI

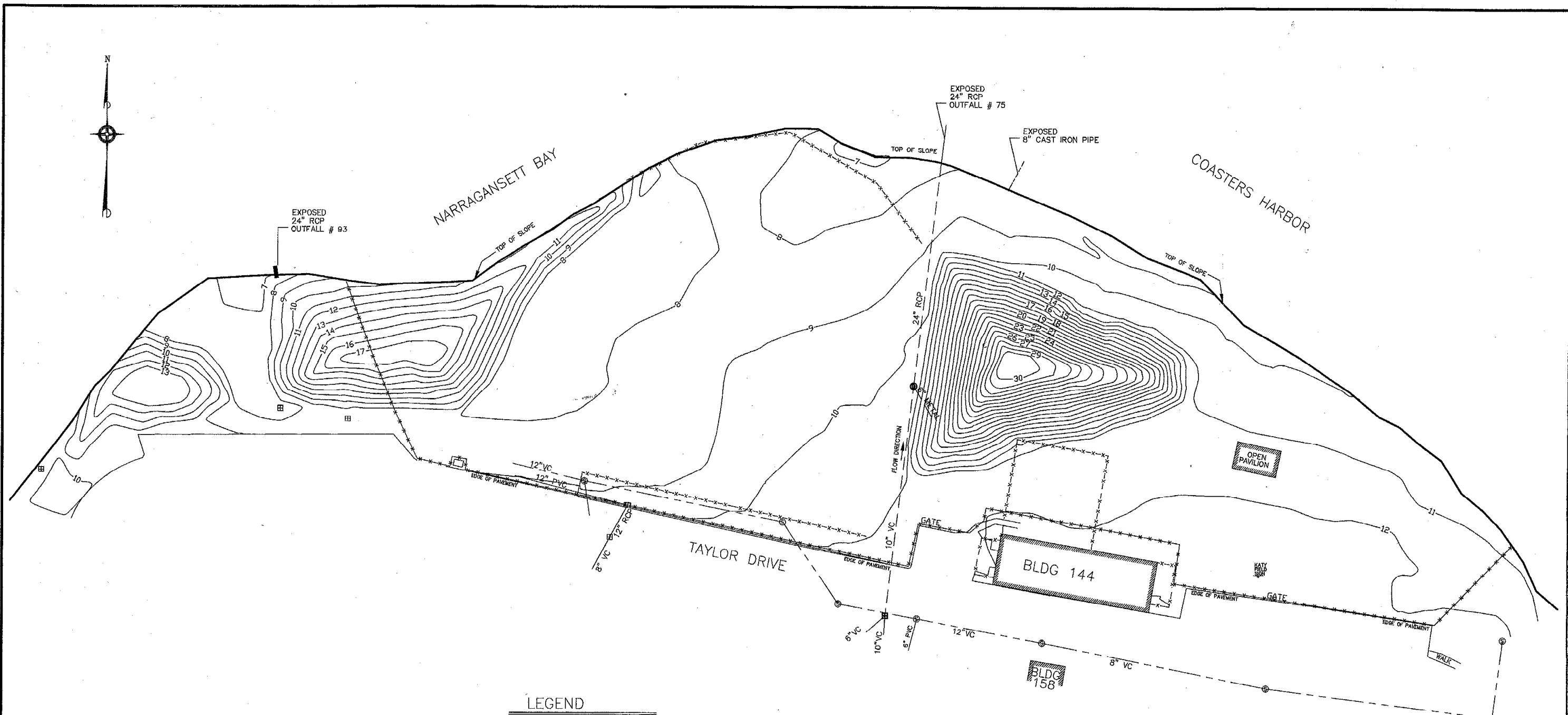
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CHECKED BY:	S. PARKER	DATE:	SEPTEMBER 25, 2003
SCALE:	AS SHOWN	ACAD:	DWG\4152\0441\FIG_2-1.DWG



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NOTES AND REFERENCES:

1. DRAWING COMPILED FROM A DRAWING ENTITLED "BASE MAP OLD FIRE FIGHTING TRAINING AREA NETC, NEWPORT, RHODE ISLAND, JULY 1997, PROJ. NO. 7578 CTO: 288, BY BROWN & ROOT ENVIRONMENTAL, SOURCE: BASE PLAN BY GUERRIERE & HALNOR, INC., DATED NOVEMBER 10, 1997, AND THE ADDITION OF FIELD MEASURED FEATURES, BY LOUIS FEDERICI AND ASSOCIATES 3/16/99, PRESENTED ON A DRAWING ENTITLED "KADY FIELD, TOPOGRAPHIC, SOIL SAMPLE LOCATION, AND SITE SURVEY AT THE OLD FIRE FIGHTING TRAINING AREA, NAVAL STATION NEWPORT IN NEWPORT, RHODE ISLAND FOR TETRA TECH NUS, INC., LOUIS FEDERICI & ASSOCIATES, 3/16/99, DWG NO. 990205-01.

2. HORIZONTAL DATUM BASE ON THE RI STATE PLANE COORDINATE SYSTEM NAD 1927. VERTICAL DATUM BASED ON NAVAL BASE MEAN LOW WATER.

3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.

4. PLAN NOT TO BE USED FOR DESIGN.

**LEGEND**

- CATCH BASIN
- SIGN
- FENCE
- EXISTING CONTOUR
- SANITARY SEWER MANHOLE
- SANITARY SEWER
- STORM SEWER MANHOLE
- STORM SEWER

**GRAPHIC SCALE**

0' 80' 160'

1 INCH = 80 FEET

<b>SITE PLAN</b>		<b>FIGURE 2-2</b>	
<b>OLD FIRE FIGHTING TRAINING AREA</b>			
<b>NAVSTA NEWPORT - NEWPORT, RHODE ISLAND</b>			
DRAWN BY: D.W.M. / R.G.D.		REV.: 0	
CHECKED BY: S PARKER		DATE: SEPTEMBER 11, 2003	
SCALE: 1" = 80'		FILE NO.: DWG\4152\0441\FIG_2-2.DWG	

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Coasters Harbor is a shallow cove connected to the East Passage of Narragansett Bay. The harbor is open at each end, north and south of Coasters Harbor Island. A wide mouth faces west at the north end of the island, and a narrow opening at the head faces south at the south end of the island. The maximum depth of the harbor at the mouth is approximately 20 feet at mean low water. At the head, the depth of the harbor is approximately 3 feet at mean low water. A tidal difference of approximately 3.5 feet has been recorded for Coasters Harbor. Circulation patterns and energies within the harbor are dominated by the tides and wind-driven flow. Hydrographic studies performed in 1996 indicate that water enters and exits at both the west and south openings and does not show a consistent directional flow pattern (Kincaid, Ellis, and DeLeo, 1996).

The estuarine system in the vicinity of OFFTA primarily includes subtidal environments, sand- or silt-substrate, with some eelgrass. The dominant taxa in the silty, subtidal, infaunal communities (less than 60 percent sand content) of Coasters Harbor included the bivalve *Nucula proxima*, *oligochaetes* species (aquatic worms), and the arthropod *Microdeutopsis*. The sandy, intertidal, infaunal communities (greater than 70 percent sand content) were found north of Coasters Harbor. Organisms and species that numerically dominated the benthic community at sandy intertidal stations included the snail *Littorina littorea*, the blue mussel *Mytilus edulis*, and, to a lesser extent, *oligochaetes* (SAIC, 2000).

The infaunal benthic, epibenthic, and pelagic communities in Coasters Harbor represent important marine habitats. Infaunal benthic communities exist within sediment depositional areas. Epibenthic communities exist on sediment depositional areas. Pelagic communities exist within the open water. Species within some of these communities include the blue mussel, the lobster (*Homarus americanus*), hard clams (*Mercenaria mercenaria*/*Pitar morrhuana*), and cunner (*Tautoglabrus adspersus*).

Other species found during field investigations of the marine environment include oysters and bay scallops. Both of these bivalves are epibenthic and very important, commercially and ecologically. Their presence in this area shows evidence of overall good health of the epibenthic environment in the subtidal areas. The benthic community is ecologically important and serves as a major food source for birds and fish, as well as for benthic and epibenthic invertebrates. As a whole, this community is potentially exposed to bulk sediment and water-borne contaminants.

An August 2001 study of the marine environment proximal to the OFFTA site revealed the presence of a large eel grass bed along the northwest side of Coasters Harbor Island. The offshore limits of the bed extended outside the study area to the west as well as to the east. The study noted that the eelgrass bed had a scale score of 4 to 5, which corresponds to between 70 percent and 100 percent coverage. Eelgrass was observed in both very dense (>70%) and sparse patches, however the dense patches were found to be much smaller than 10 feet in diameter. Oysters were also found in abundance during the

study. This species was identified as dominating the eastern portion of the study area. Species diversity, including both plant and animal seemed to increase from east to west. Other identified species include quahogs, mussels (in shallow water) and numerous types of vegetation and algae. Some scallops were observed during the study, and it is speculated that more scallops are also present within the eelgrass bed, however it was difficult to investigate their presence due to the density of the beds (Pare, August 2001).

The Rhode Island Department of Environmental Management (RIDEM) has designated the area of Narragansett Bay along the NAVSTA Newport shoreline, including Coasters Harbor, as a shellfish closure area due to known or potential sewage discharges in the area. However, the effectiveness of the ban for preventing shellfishing is uncertain, and the ban applies only to a few species of shellfish (bivalves only); it does not apply to lobster or finfish.

## **2.2 SITE HISTORY**

The NSN facility has been in use by the Navy since the era of the Civil War. During World Wars I and II, military activities at the facility increased significantly and the base provided housing for many servicemen. In subsequent peacetime years, use of on-site facilities was slowly phased out until Newport became the headquarters of the Commander Cruiser-Destroyer Force Atlantic in 1962. In April 1973, the Shore Establishment Realignment Program (SER) resulted in the reorganization of naval forces, and activity at the base again declined. This reorganization resulted in the Navy excessing some 1,629 acres of its 2,420 acres. Portions of the facility are currently leased by the Navy to the State of Rhode Island Port Authority and Economic Development Corporation. Some of these areas are, in turn, subleased to private enterprises.

The entire NSN was listed on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) of abandoned or uncontrolled hazardous waste sites in November 1989. The NPL identifies those sites that pose a significant threat to the public health and environment. The OFFTA site was listed as one of the sites requiring RI/FS activities. It is currently being studied by the Navy under the Department of Defense Installation Restoration Program (IRP). This program is similar to the EPA's Superfund Program authorized under CERCLA in 1980, as amended by SARA in 1986.

A Federal Facilities Interagency Agreement (FFA) for NSN (then NETC) was signed by the Navy, the State of Rhode Island, and the EPA on March 23, 1992. The FFA outlines response action requirements under the Department of Defense IRP at NSN. The FFA was developed, in part, to ensure that environmental impacts associated with past and present activities at NSN are thoroughly investigated and remediated, as necessary.

The OFFTA site was home to a Navy fire fighting training facility from World War II until 1972. During the training operations, fuel oils were ignited in various structures at the site that simulated shipboard compartments, and then extinguished by sailors. It was reported that the two "Carrier Compartment" buildings were injected with a water/oil mixture which was subsequently set on fire for fire fighting practice. Underground piping reportedly carried the water/oil mixture to the buildings and from the buildings to the oil-water separator shown on the figure. No other known information is available concerning the prior fire fighting training operations.

The fire fighting training facility was closed in 1972. Upon closure, the training structures were reportedly demolished and buried in mounds on the site, and then the entire area was covered with topsoil. The site was then converted to a recreational area with a playground, a baseball field, and a picnic area with an open pavilion and barbecue grills. The field was dedicated on July 4, 1976, and used as a recreational area until its closure in October 1998 due to potential environmental and human health concerns.

In its 22 years as a recreational area, the site was used for organized activities including youth day camps, picnic functions, and little league baseball (1 year only), as well as for general recreation. A child day care center operated out of Building 144 on the site from approximately 1983 through January 1994 when it was relocated off site to a larger facility on base.

Aerial photos and facility maps for the period from 1939 through 1988 were reviewed to better evaluate the site history. Activity on the site appears to date back to approximately 1943. A 1953 facility design map indicates the locations of structures and site features associated with fire fighting training exercises. An aerial photo taken in May 1944 depicts the site with structures in a similar layout to that shown on the 1953 facility design map. Based on the design map and subsequent facility condition maps, on-site structures included an administration building, hose house, two carrier compartments, smothering pit, separator pit, foam pit, simulated ship structures, suction pumps, and oil tanks.

The indexes that accompanied some of the facility conditions maps indicate that the on-site structure that was used in recent years as a day care center was once used as "wash and dressing rooms." No significant visible site changes are noted from 1944 until a 1975 aerial photo of the site, when the structures and facilities associated with the fire fighting training area are no longer evident, with exception of the "hose house" and day care center structure. As of 1987, the site appears similar to its current condition, with soil mounds visible in the central and western portions of the site and a pavilion in the east-central portion of the site.

## 2.3 PREVIOUS STUDIES

Numerous studies have been conducted on the OFFTA site, the following sections describe the studies on marine sediment and groundwater, pertinent to the work described in this monitoring work plan.

### 2.3.1 Marine Sediment Studies

A series of studies have been conducted on the chemical conditions in the marine sediment proximal to the OFFTA site. The first such study was a marine Ecological Risk Assessment (ERA) (SAIC, 2000) performed to assess ecological risks to the offshore environments of Coasters Harbor and Narragansett Bay from contaminants associated with OFFTA. The ERA included exposure and effects assessments, a characterization of risk, risk synthesis, and uncertainty analysis.

Risks were identified by stations, based on summaries of each weight of evidence, focusing on the exposure (contaminants present) correlated to effects (reproduction and growth inhibitions, etc). Stations were rated from these summaries as exhibiting high, intermediate, or low probability for adverse risk to receptors present at those stations.

The assessment found a high probability for adverse risk at one station (SD-05) close to the outfall at the central shoreline of the site, likely from PAHs and metals present at this area. Intermediate probability for risk was estimated for a number of stations at the nearshore area and in the harbor sediment, including one reference station south of Coasters Harbor, but because a clear exposure-response relationship was not found, these risks may be considered acceptable from an ecological perspective. Low probability for adverse risk was estimated for the remainder of the stations, including one reference station and the nearshore stations more exposed to rough water conditions. The observed risks at these stations are considered acceptable from an ecological perspective. A baseline condition associated with relatively pristine conditions was not observed at any of the site or reference stations evaluated in the risk assessment.

The findings from the ERA were included in a Feasibility Study (FS) conducted to evaluate various ways to address the soil and marine sediment at the OFFTA site. Previous studies were utilized in creating the FS, including several phases of remedial investigations, a human health risk assessment, and the marine ERA discussed above. The FS evaluated options for monitoring and removal actions for soil, groundwater and marine sediment.

Following the FS, two phases of predesign work were conducted on the marine sediment. These pre-design studies were conducted to better refine the areas of sediment that exceed preliminary cleanup



goals stated in the FS, and to determine the source of PAHs and metals found to ensure that the area would not become recontaminated by an unknown source if sediment removal was undertaken.

The predesign investigations found that PAHs in the sediments were focused on the areas of two outfalls. These outfalls discharge storm water collected from a large portion (almost 9 acres) of the north end of Coasters Harbor Island. Forensic petroleum fingerprinting and detailed PAH analysis of sediments collected from the marine sediment, the on-site soil, the groundwater, and the storm drain system indicated that the hydrocarbons in the marine sediment were more similar to those in the sediment found in the storm drains than the hydrocarbons found in the soil or the groundwater at the site (TtNUS 2002, Battelle, 2002).

### **2.3.2            Groundwater Studies**

The groundwater at the site was briefly evaluated in the remedial investigation report for the site. Following the completion of the RI, a Groundwater Risk Evaluation was conducted to measure human health risks from possible exposures to the groundwater. The groundwater risk evaluation found that cancer and non-cancer risks under a household water use scenario were notable, but there was a very low likelihood of risks from incidental contact with groundwater, which is the only plausible scenario for groundwater exposure at this site. The proximity to the ocean, the state classification of groundwater at this site as GB, the brackishness of the groundwater and the availability of city water supply to the site preclude practical use of groundwater taken from the site as water supply (TtNUS 2002a).

The feasibility study did identify preliminary remediation goals (PRGs) for the groundwater at the site based on risk (residential use), RIDEM GA Groundwater objectives, and on Federal MCLs. However, due to the lack of a completed residential exposure pathway, remediation of groundwater is not deemed necessary at this time.

### **2.4                SAMPLING AND ANALYSIS PROGRAM DESIGN AND DQOs**

This monitoring program involves the sampling and analysis of groundwater and marine sediments. It has been developed to provide groundwater data prior to initiation of soil removal actions and sediment data after the first phase of the soil removal action. These data will be compared to previously measured conditions. Thus sample stations are selected from those sampled in previous efforts, and sample analytical methods are those that were used in previous studies as recent as 2002. Selection of sediment sampling locations for this investigation was made based on the highest concentrations of contaminants previously detected, and probable contaminant transportation routes from the work areas and from shore

areas. The sediment sample station selection process is presented in Section 3.2. All available groundwater sample points will be used for groundwater sampling.

The data quality objectives (DQOs) for this project were developed in accordance with the EPA Guidance for Data Quality Objectives (EPA G4 document). The G4 document suggests seven steps be followed to develop project DQOs. The objectives are in part dictated by CERCLA guidance, the Federal Facilities Agreement, and other standard guidance documents on how to perform investigations.

The intended use of the data resulting from a field investigation is the primary determining factor in defining the DQOs for that data. To be certain that the data are consistent with the goals of the investigation, the seven steps of defining DQOs are presented in this section.

#### **2.4.1            Statement of the Problem**

As detailed in Section 2.2, the OFFTA site was home to a Navy fire fighting training facility from World War II until 1972. During the training operations, fuel oils were ignited in various structures at the Site that simulated shipboard compartments, and then extinguished by sailors. Currently, as a result of these activities, there are PAHs and petroleum present in soil, groundwater and possibly marine sediments at the OFFTA Site. Although there are hydrocarbon contaminants present in the sediment at the site, forensic analysis of samples collected from the soil, the marine sediment, and the sediments captured within storm drains upgradient of the site indicate that the hydrocarbons in the sediments are more similar to those in the storm drains than those in the soils at the site (TtNUS, 2002c).

A removal action is planned to address the impacted soil at the site through removal and off-site disposal. During the removal action, PAHs and metals from or within the soils may become liberated and could migrate to the shallow groundwater or to the marine ecosystem at the site. The soil removal action will be conducted to a depth that is anticipated to intercept the groundwater table, and therefore liberation of silts and some impacts from the soils could occur. Similarly, impacted soil may be transported to the sediment through excavation of soil adjacent to the shoreline for revetment installation and through dewatering activities. These site-related inputs will be minimized to the extent possible, but some impact is likely. One of the removal action objectives stated in the FS report, is that short term degradation from soil removal is minimized and reversed, and no further degradation from the site occurs after the removal action is completed.

In addition, non-site related inputs such as onshore storm water drainage and offshore ambient bay concentrations will continue to contribute to sediment impacts. The extent of the non-site related inputs must be identified and separated from the site related inputs, and be controlled if possible.

The monitoring program presented in this work plan will address the possibility of marine sediment and groundwater degradation from the soil removal actions. Changes in the sediment and eelgrass will be identified by comparing sediment monitoring data and extent of eelgrass mapped to previously measured data. The monitoring data will separate non-site related contaminant inputs to sediment, and will identify the extent of contamination contributed by these inputs. The monitoring effort will be conducted to measure concentrations of contaminants of concern (COCs) established in the RI and the FS reports for groundwater and sediment.

The process for these comparisons is described in Section 2.4.5 of this work plan.

#### **2.4.2            Identification of the Decision**

Under the monitoring program, four decision points will be met:

- 1) Are chemical concentrations in sediments after soil removal actions higher or lower than those measured before the soil removal actions and are habitats degrading (point comparisons and comparisons of the means)?
- 2) Have chemical concentrations in groundwater changed since prior sampling events (point comparisons)?
- 3) Are the chemical concentrations in excess of the risk based Preliminary Remediation Goals (PRGs) set in the FS report (point comparisons)?
- 4) Do the chemicals (specifically PAHs) present at site originate from site related sources or from sources off-site such as stormwater and ambient bay inputs?

#### **2.4.3            Inputs to the Decision**

Inputs to the decision are the elements used in the decision process. Inputs to the decision as stated in Section 2.4.2 are as follows:

Sediment:

- COCs and PRGs established in the FS for sediment.
- Concentrations of COCs previously measured in sediment.
- Concentrations of COCs in sediments from background/reference locations.
- Possible source of COCs in sediment determined by forensic testing.

- Locations of sediment samples where contaminants are found.
- Concentrations of parameters measured.

PAH concentrations were previously measured in sediment during three separate events, including the ecological risk assessment (SAIC, 2000), the Sediment Predesign Investigation (TtNUS 2002b) and the Phase II Sediment Predesign Investigation (TtNUS 2002c). These different efforts collectively identified several areas at the shoreline of the site where petroleum – derived PAHs were found at concentrations that may pose risk to the ecological receptors.

Groundwater:

- COCs and PRGs established in the FS for groundwater.
- Concentrations of COCs previously measured in groundwater.
- Concentrations of COCs in groundwater upgradient of the site.
- Locations of groundwater samples where COCs exceeding PRGs are found.
- Concentrations of COCs measured.

Organic compounds and metals concentrations were previously measured in groundwater in 1997, reported in the Remedial Investigation Report (TtNUS 2001) and again in 2002, reported in the Phase II Sediment Predesign Investigation (TtNUS 2002c).

Source of contaminants in sediments will be assessed through forensic testing as described in Section 2.4.5.3 of this work plan and in the Phase II Sediment Predesign Investigation (TtNUS 2002c) and its attachments (Battelle, 2002).

**2.4.4      Definition of the Study Boundaries**

Physical study area boundaries include the specific locations of the Site where concentrations of PAHs and metals were previously measured in sediment and in groundwater in excess of the PRGs. These are specific locations previously sampled, that are identified in Section 3 of this work plan.

**2.4.5      Decision Rule**

The decision rule is a statement defining the criteria to be used to decide whether action may be required. Separate decision rules are established for sediment and groundwater evaluations in the subsections that follow.

reference station, and 2 storm drain stations (forensic analysis only) (upgradient). Selection of sample stations is provided Section 3 of this work plan.

The analysis will include the following for each COC:

- Point comparisons using line graphs of observed concentrations for each site station.
- Calculation of the means, range, standard deviation of the site station data.
- Graphic representation of mean and range using “box-whiskers” chart or a similar evaluation tool, appropriate for small data sets collected.
- Preparation of a frequency histogram of the site station data.
- Comparison of the means through selected testing (appropriate t-test for two populations of the same size from the same stations).

Two events are already completed for groundwater to date (1997, reported in TtNUS, 2001; and 2002, reported in TtNUS, 2002c). Two events are also available for most of the site sediment stations of interest (2001, reported in TtNUS, 2002b; and 2002, reported in TtNUS, 2002c) it should be noted that for the 2001 sampling event there are no data available for two western most site sediment stations.

The testing described above will be used to determine if the data for groundwater or sediment indicates an increase in COC concentrations either at point measurements or across those data sets. If an increase is noted for groundwater, the source of that increase will be identified through additional testing and evaluation, and controlled as necessary. If an increase is noted in the sediment, the forensic data evaluations will be applied to determine the source of the contaminants in the stations where the increases were evident. If the source is found to be residual contaminants from the site, some sediment mitigation will need to be considered.

#### Forensic Data

Forensic data will be used to meet the fourth decision point presented in Section 2.4.2 of this work plan:

Forensic data will be collected and compared with that collected in 2002 and reported by Battelle (2002). The resulting data from this analysis is a semi-qualitative measurement, using different analytes detected to type out the PAHs present in the sediment, and not a strictly quantitative measurement, comparing

against a criteria. This data simply shows defined patterns for each source (i.e. site contaminants vs. urban runoff) and associates those patterns with each station. Therefore, the comparison of the forensic data will be a qualitative one: this analysis will consist of a comparison of high resolution hydrocarbon fingerprints, PAH analyte patterns, analyte ratios (scatter plots) alkane fingerprints, and biomarker fingerprints identified in the samples from each round of data to those identified in specific samples collected in 2002. If similarities are not clearly evident, the data will be reanalyzed to determine if a new source is providing contaminants to the site stations, or if contaminants from the site have had a new impact to the sediment near the site.

Should the forensic testing show that stations where increases in COC concentrations are found are site related, this will be a negative decision on the null hypothesis, that the site is contributing to the sediment PAH concentrations. Should the forensic testing show that stations where increases in COC concentrations are found are not site related, and are instead related to urban runoff, or some other source, this would constitute a positive decision on the null hypothesis, that the site is not contributing to the sediment PAH contaminant concentrations.

#### Eelgrass Data

The extent of eelgrass will be measured to support the above assessments and meet the first decision point provided in Section 2.4.2 of this work plan.

The eelgrass extent is to be used as an indicator of the overall health of the ecosystem. Site related releases are only one stressor to the environment at the site, and others may not be measured in the assessments described above. If activity at the site is impacting the habitat, this may be evident in the reduction of the extent of eelgrass, which has established itself in a large stand on the west portion of the subtidal slope near the site. Mapped extents will be compared qualitatively (health and approximate plant density) and quantitatively (boundaries of established bed and patches) by diver surveys. Transects will be established and extent distances will be checked during each sampling event, and the extents will be remapped, and compared with those conducted previously to determine growth or reduction.

#### **2.4.6**      Limits on Decision Errors

This section discusses the possibility of decision errors, i.e. tolerance on false positive or false negative decisions. For this effort, it is the intention of the Navy to provide adequate checks to assure that unnecessary mitigation is not attempted without assurances that the work is necessary. This approach will assure that sediments and sensitive ecological environments are not impacted.

The null hypothesis for this monitoring effort will be that contaminant concentrations will not change after the first phase of the soil removal action, and that if they do change it will likely be a result of another input, such as urban runoff via storm water discharge. The alternative hypothesis is that COCs may migrate to the marine sediment from the site activities. Based on these hypotheses, a false positive identification of an increase in the COCs and a false positive decision on identification of the source through forensic testing could lead to identification of the need to mitigate contaminants in the sediment where none was necessary. Using the chemical and the forensic data together, two false positive decisions would have to be made to lead to a determination of a contaminant release from the site when there was none.

On the contrary, a false negative decision would be an erroneous measurement of the sediment showing a lower concentration of the contaminants that actually exist, and that the COCs in sediment are associated with urban runoff, when in fact they are associated with releases from the site. The tolerance for the false negative decision is compensated by best practices used by the sampling crew, as well as by the analytical laboratories, the quality control procedures and methodologies set up by the project group, and the oversight provided by the regulatory parties.

#### **2.4.7            Design for Obtaining Data**

The DQO process described in the G4 DQO document describes the use of various statistical approaches for developing a database. A statistical approach for sampling design is best used to find hot spots or resolve a specific removal area. While statistical analysis of the data is anticipated, a statistical approach was not used for selection of sampling stations for this monitoring effort. Instead, as detailed in Section 3.2 and Section 2.4, this plan is developed based on previous data that identified specific areas of potential concern. This investigation is designed around that data to assure conditions in these areas are not degraded by the upcoming construction actions, or by the site in the long term. Therefore, analysis methods are selected to provide good comparison with previous analysis, and sample stations and depth intervals are selected from those which were sampled during prior events and provided meaningful data.

The sediment sampling plan focuses on near-shore sediment stations that previously were found to exceed PRGs or have high concentrations of PAHs. Depth intervals are selected to be the same as for previous events (0-0.5 feet below top of sediment). Details on sediment sampling and analysis are provided in Section 3.2 of this work plan.

The eelgrass monitoring effort is designed to mirror that which was originally conducted in 2001 to establish an extent of eelgrass near the site. Only through reproduction of the original survey can the

results be compared meaningfully to identify changes. This effort is described in Section 3.3 of this work plan.

The groundwater monitoring effort is designed to duplicate efforts conducted in 2002. All available groundwater monitoring points will be used for the groundwater monitoring effort. Sample collection and analysis will be the same as that conducted in 2002.

Specifics on the precision, accuracy, etc. of the data collected are described in the Quality Assurance/Quality Control Plan, presented in Section 4 of this work plan.



### **3.0 FIELD SAMPLING PLAN**

This section presents a description of the field sampling activities that are planned for the marine sediment and groundwater monitoring program for the Old Fire Fighting Training Area at the Naval Station - Newport, in Newport, Rhode Island.

This field sampling plan has been prepared in accordance with the objectives outlined in Section 1.1 of this work plan, and the data quality objectives detailed in Section 2.4 of this work plan.

The following sections detail the sediment and groundwater monitoring activities described under this work plan. Figures 3-1 and 3-2 depict the proposed sampling locations.

Activities associated with the monitoring investigations include:

1. Mobilization/demobilization activities.
2. Collection of core sediment samples to evaluate the existing surface conditions at former hot spots.
3. Mapping the extent of eelgrass near the site to determine if any changes have occurred since 2002.
4. Collection of groundwater samples to evaluate existing groundwater condition and compare against previous data collected.
5. Laboratory analysis of groundwater and sediment samples collected.
6. Investigation-derived waste (IDW) disposal activities.

#### **3.1 MOBILIZATION/DEMOBILIZATION**

Mobilization activities will include efforts for preparation of the field investigations. These efforts include:

- Preparation of technical specifications for sample collection and analysis subcontracts.
- Ordering and mobilizing required field equipment and supplies to the site.
- Field team members' review of site control and planning documents including Work Plan, the Health and Safety Plan (provided under separate cover), applicable Standard Operating Procedures (SOPs, included as Appendix A), and applicable subcontract specifications.

- Field team orientation meeting(s) to familiarize the field team and subcontractor personnel with site investigations objectives and procedures, equipment, access and health and safety requirements appropriate for the scope of the field activities.

### **3.2 SEDIMENT SAMPLE COLLECTION**

An estimated 12 samples will be collected from previous locations where PAHs were identified at elevated concentrations. Figure 3-1 presents the proposed sediment sample stations. Table 3-1 provides a rationale for selection of the proposed stations. Stations may be located visually if previous station identifiers are still present (buoys and or stakes installed during previous sampling efforts). If not, locations will be identified in the field using Global Positioning System (GPS) and re-marked with an anchored buoy or grade stake. Plan-view photos will be taken of each sample station for the field record.

Sediment cores from intervals of 0.0-0.5 feet will be collected from stations identified on Figure 3-1. Samples at stations that can be accessed from shore will be collected by hand, using an acetate lined coring device. For stations that are located under deeper water, samples will be collected using the same coring device, operated by a subcontracted diver. If refusal is encountered at any depth above the target depth for that location, the sampler will move no further than a one-half meter radius from the initial position. If refusal above the target depth is encountered after four attempts, then the samples from the core with the maximum depth achieved will be selected for analysis.

It is anticipated that the sampling will be conducted from shore and from an open 20 foot work boat. A subcontracted commercial diver will carry out the under water sample collection under the supervision of a TtNUS field geologist/engineer. Sediment core samples will be collected utilizing a decontaminated split-spoon-like, acetate-lined stainless steel sampling device. The sampler will drive the coring device into the sediment to the target depth, then remove the acetate liner and place end caps on it to retain the sediment structure. Samples will be lifted to the surface and passed to a TtNUS representative. The TtNUS field representative will carefully extract the sample from the core tube, and deposit it into a stainless steel bowl. The field scientist will inspect the material and describe the core sample on a sample log sheet. Each core will be inspected for visual evidence of potential contamination, and then packaged for shipment to the analytical laboratory. Large stones and shell matter will be removed. In the event that the resulting sample volume is not sufficient to fill sample jars from the selected interval, a second co-located coring may be advanced in order to provide sufficient sediment volume for all analyses.

All non-disposable sampling equipment will be decontaminated in accordance with the procedures identified in Section 3.6.

**TABLE 3-1**  
**SEDIMENT SAMPLE STATION SELECTION RATIONALE**  
**DRAFT WORK PLAN FOR SEDIMENT AND GROUNDWATER MONITORING**  
**OLD FIRE FIGHTING TRAINING AREA**  
**NAVSTA NEWPORT, NEWPORT, RHODE ISLAND**

Station ID	Selection Rationale
SD-5 (formerly OFF-5) <sup>(1,2)</sup>	Located at primary outfall, estimated to pose a high probability for ecological risk to ecological receptors in the ecological risk assessment, results from 1997 sampling exceeded PRGs calculated for ecological and human health exposures.
OFF-6 <sup>(2)</sup>	Results from 1997 sampling exceeded PRGs calculated for ecological and human health exposures.
OFF-3 <sup>(2)</sup>	Located near outfall #093 on west side of site, results from 1997 sampling exceeded PRGs calculated for ecological and human health exposures.
410 <sup>(1,2)</sup>	Located outfall #093 on west side of site, results from 2001 and 2002 sampling exceeded calculated PRGs.
471 <sup>(1,2)</sup>	Located west of outfall #093 results from 2002 sampling exceeded calculated PRGs for Benzo(a)pyrene.
475	Located west of outfall #093 results from 2002 sampling exceeded calculated PRGs for Benzo(a)pyrene.
414 <sup>(2)</sup>	Within the intertidal zone, results from 2001 sampling exceeded PRGs calculated for ecological and human health exposures.
442 <sup>(2)</sup>	Within the intertidal zone, located near large mound on shore, results from 2001 sampling exceeded PRGs calculated for ecological and human health exposures.
JPC03 <sup>(2)</sup>	Reference station sampled in 1997, 2001, and 2002.
OTS-OF093 <sup>(1)</sup>	Sediments within storm drain leading to outfall #093, sampled in 2002.
OTS-OF075 <sup>(1)</sup>	Sediments within storm drain leading to outfall #075, sampled in 2002.
Not selected	Twelfth sample available for placement per oversight request.

## Notes:

- (1) Forensic analysis conducted during 2002 Phase PDI by TtNUS.  
(2) EPA recommendations – 4/8/04 (TtNUS, May 2004)



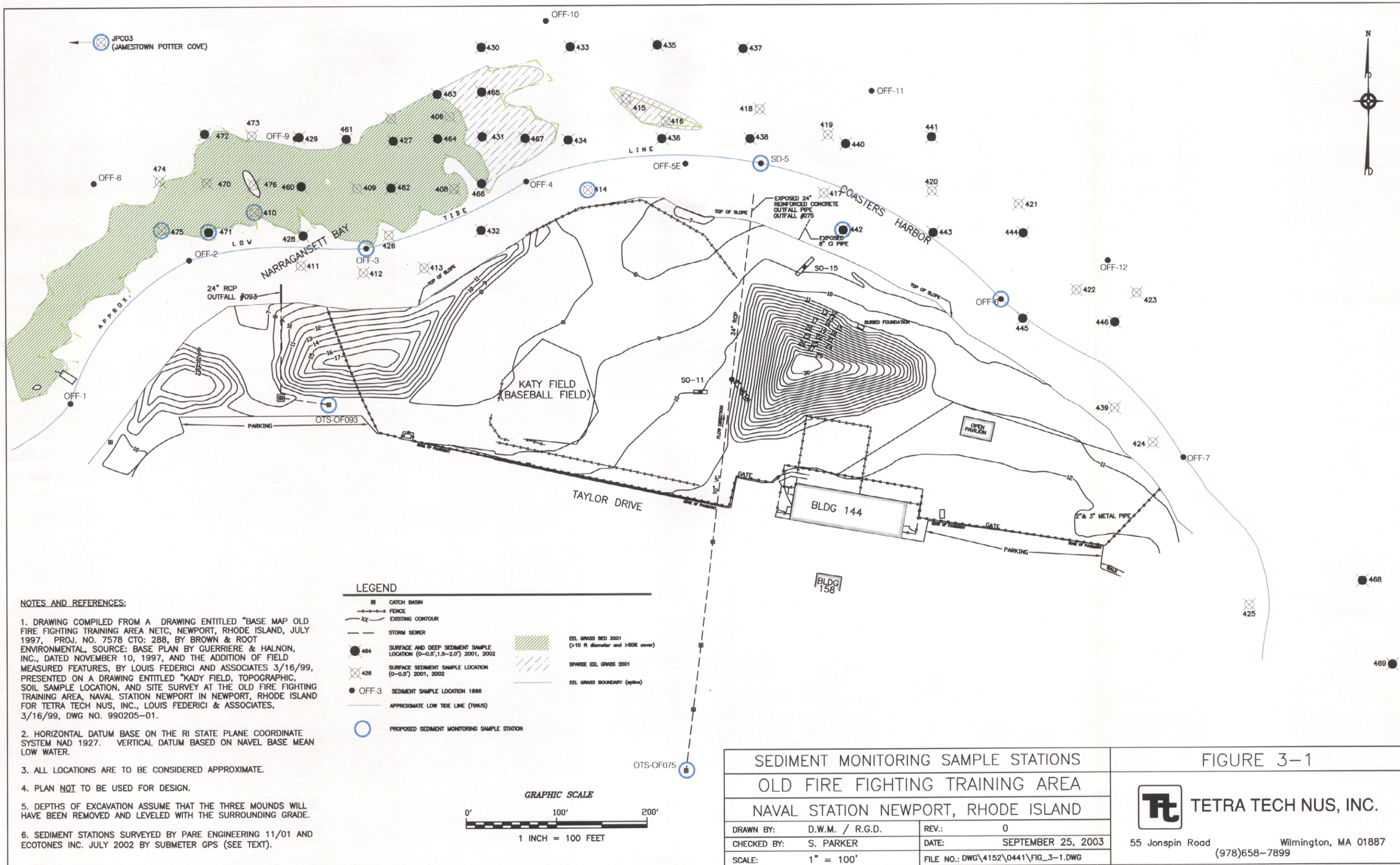




Table 3-2 presents a summary of field and QC samples, Table 3-3 presents the analytical methods, volume and preservatives required.

### **3.3 EELGRASS MAPPING**

The extent of eelgrass identified in July 2001 will be checked and re-mapped in order to assist in the evaluation of any degradation of the marine environment. Eelgrass is an ecologically important species as subtidal ground cover and is sensitive to pollution and other disturbances. Therefore the eelgrass areas are considered an area of ecological concern at the site.

The eelgrass was previously mapped by divers swimming a series of transects beginning at points set 10 feet apart along the shoreline. The transects were extended to a distance of approximately 150 feet from the shoreline, oriented perpendicular to the shore. Limits of the eelgrass at the transect lines were recorded using differential GPS that was later calculated to have a precision of between 0.71 and 0.98 meters. Figure 3-1 depicts the extent of eelgrass mapped in 2001.

The extent of eelgrass will be remapped using the same techniques as those described above. Remapping the eelgrass is included as a part of this monitoring effort in order to help determine the overall health and condition of the ecosystem, as well as to determine whether the size of the eelgrass bed has changed. Visual observations of eelgrass health and organisms utilizing the eelgrass beds will be recorded to aid in documenting the health and condition of the ecosystem. Eelgrass is impacted by water quality as well as physical stresses such as siltation and scouring. Healthy eelgrass stands will grow and shrink depending on numerous variables, however, significant sudden changes may be indicative of environmental conditions associated with nearby construction on the on shore portions of the site or on the shoreline.

Any changes to the beds mapped in 2001 will be identified in revised maps to be provided in the monitoring report (Section 5 of this work plan).

### **3.4 GROUNDWATER SAMPLE COLLECTION**

Up to fifteen groundwater wells will be sampled as a part of the monitoring effort. Data will be collected for comparison with previously collected data (1997 and 2002) in order to identify any degradation of the groundwater quality. Locations of existing wells are provided on Figure 3-2.

Prior to groundwater sampling, all monitoring wells to be sampled will be checked for the presence of non-aqueous phase liquid (NAPL) using an electronic interface probe.

**TABLE 3-2**  
**FIELD AND QUALITY CONTROL SAMPLE SUMMARY**  
**DRAFT WORK PLAN FOR SEDIMENT AND GROUNDWATER MONITORING**  
**OLD FIRE FIGHTING TRAINING AREA**  
**NAVSTA NEWPORT, NEWPORT, RHODE ISLAND**

SAMPLE TYPE	ANALYSIS	FIELD SAMPLES	TRIP BLANKS <sup>(1)</sup>	FIELD (AMBIENT) BLANKS <sup>(2)</sup>	RINSATE (EQUIPMENT) BLANKS <sup>(3)</sup>	FIELD DUPLICATES <sup>(4)</sup>	TOTAL
Sediment	PAHs: SW846,8270C SIM	12	0	2	2	1	17
	TAL Metals	12	0	2	2	1	17
	PAH Forensic Analysis	12	0	0	0	1	13
	TPH Fingerprint	12	0	0	0	1	13
Groundwater	VOCs: SW846, 8260B	15	1	2	1	2	21
	TPH SW846, 8015A	15	0	2	1	2	20
	SVOCs - SW-846/8270C	15	0	2	1	2	20
	TAL Metals	15	0	2	1	2	20

Notes:

- (1) One per sample shipment (VOCs only)
- (2) One per sampling event (assume 1 for grid samples and 1 for supplemental samples).
- (3) Collect one rinsate blank per sampling day.
- (4) Collect 1 per 10 field samples.

**Definitions:**

- SW-846 - Test Methods for Evaluating Solid Waste, USEPA Office of Solid Waste and Emergency Response
- PAH - Polycyclic Aromatic Hydrocarbons
- TAL - Target Analyte List
- TPH - Total Petroleum Hydrocarbons
- VOC - Volatile Organic Compounds
- SVOC - Semivolatile Organic Compounds
- SIM - Selected Ion Monitoring

**TABLE 3-3**  
**ANALYTICAL METHODS, SAMPLE CONTAINER, PRESERVATIVE, AND HOLDING TIME REQUIREMENTS**  
**DRAFT WORK PLAN FOR SEDIMENT AND GROUNDWATER MONITORING**  
**OLD FIRE FIGHTING TRAINING AREA**  
**NAVSTA NEWPORT, NEWPORT, RHODE ISLAND**

SAMPLE MEDIUM	ANALYSIS <sup>(2)</sup>	SAMPLE CONTAINER <sup>(1)</sup>	PRESERVATIVE	HOLDING TIME
Soil	PAHs, SW-846 8270C SIM	8 oz wide mouth jar	Cool to 4°C	7 Days (Extraction)
Sediment	TAL Metals SW-846 6010B Trace <sup>(3)</sup>	4 oz wide mouth jar	Cool to 4°C	14 Days (Analysis)
	TPH Fingerprint (GC/FID) <sup>(4)</sup>	8 oz wide mouth jar	Cool to 4°C	7 Days (Extraction)
	PAH Forensic (GC/MS/SIM) <sup>(4)</sup>			
Aqueous	VOCs, 8260B	40 ml VOA Vials	HCl to pH <2, Cool to 4°C	7 days (Analysis)
	SVOCs, SW-846 8270C SIM	1 Liter Amber	Cool to 4°C	7 Days (Extraction)
	TPH SW-846/8015A	1 Liter Amber	H <sub>2</sub> SO <sub>4</sub>	14 Days (Analysis)
	TAL Metals SW-846 6010B Trace <sup>(3)</sup>	1 Liter Polyethylene	Nitric Acid to pH <2	14 Days (Analysis)

Notes:

(1) Triple volume needed for organic laboratory QC, and double volume needed for metal laboratory QC, at a rate of one per 20 field samples. Also, actual volumes and bottle requirements needed for all analyses will be verified with the selected analytical laboratory prior to initiation of sampling event.

(2) Method detection limits adequate for determining PRG exceedances, as discussed in Section 2.5.3.

(3) ICP mass spectrometry may be used for analysis at detection limits necessary.

(4) TPH Fingerprint and PAH Forensic analysis is laboratory-specific (Emsbo-Mattingly, et al 2001; Stout et. al. 2002)

**Definitions:**

H<sub>2</sub>SO<sub>4</sub> - Sulfuric Acid

HCL - Hydrochloric Acid

SIM - Selected Ion Monitoring

GC/MS - Gas Chromatograph/Mass Spectrometry

FID - Flame Ionization Detector

SW-846 - Test Methods for Evaluating Solid Waste, USEPA Office  
of Solid Waste and Emergency Response

PAH - Polycyclic Aromatic Hydrocarbons

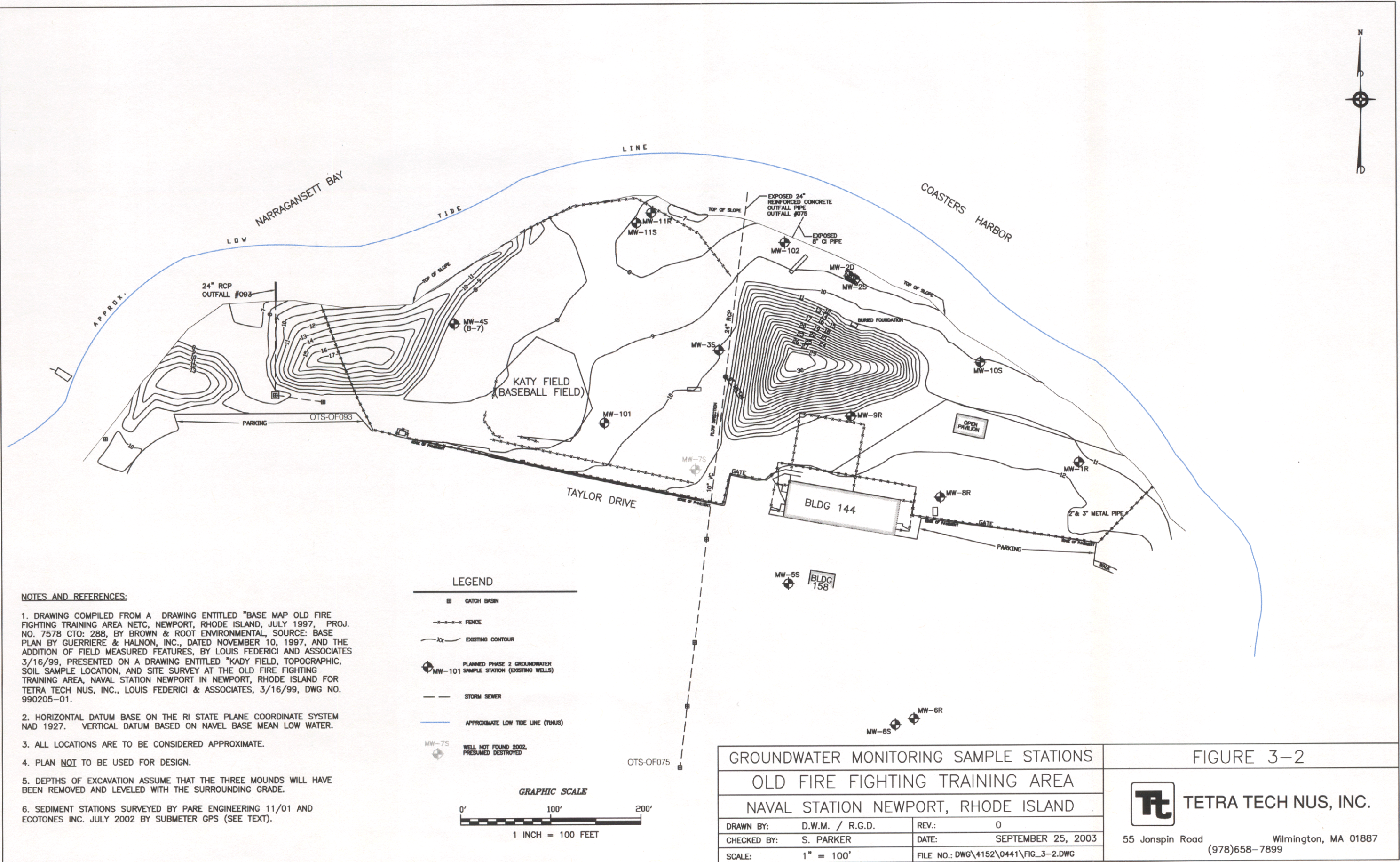
TAL - Target Analyte List

VOC - Volatile Organic Compounds

SVOC - Semivolatile Organic Compounds

TPH - Total Petroleum Hydrocarbons





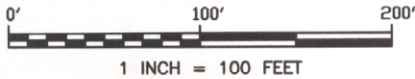
NOTES AND REFERENCES:

- 1. DRAWING COMPILED FROM A DRAWING ENTITLED "BASE MAP OLD FIRE FIGHTING TRAINING AREA NETC, NEWPORT, RHODE ISLAND, JULY 1997, PROJ. NO. 7578 CTO: 288, BY BROWN & ROOT ENVIRONMENTAL, SOURCE: BASE PLAN BY GUERRIERE & HALNON, INC., DATED NOVEMBER 10, 1997, AND THE ADDITION OF FIELD MEASURED FEATURES, BY LOUIS FEDERICI AND ASSOCIATES 3/16/99, PRESENTED ON A DRAWING ENTITLED "KADY FIELD, TOPOGRAPHIC, SOIL SAMPLE LOCATION, AND SITE SURVEY AT THE OLD FIRE FIGHTING TRAINING AREA, NAVAL STATION NEWPORT IN NEWPORT, RHODE ISLAND FOR TETRA TECH NUS, INC., LOUIS FEDERICI & ASSOCIATES, 3/16/99, DWG NO. 990205-01.
- 2. HORIZONTAL DATUM BASE ON THE RI STATE PLANE COORDINATE SYSTEM NAD 1927. VERTICAL DATUM BASED ON NAVAL BASE MEAN LOW WATER.
- 3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
- 4. PLAN NOT TO BE USED FOR DESIGN.
- 5. DEPTHS OF EXCAVATION ASSUME THAT THE THREE MOUNDS WILL HAVE BEEN REMOVED AND LEVELED WITH THE SURROUNDING GRADE.
- 6. SEDIMENT STATIONS SURVEYED BY PARE ENGINEERING 11/01 AND ECOTONES INC. JULY 2002 BY SUBMETER GPS (SEE TEXT).

LEGEND

- CATCH BASIN
- FENCE
- EXISTING CONTOUR
- PLANNED PHASE 2 GROUNDWATER MW-101 SAMPLE STATION (EXISTING WELLS)
- STORM SEWER
- APPROXIMATE LOW TIDE LINE (TANUS)
- MW-7S WELL NOT FOUND 2002, PRESUMED DESTROYED

GRAPHIC SCALE



GROUNDWATER MONITORING SAMPLE STATIONS  
OLD FIRE FIGHTING TRAINING AREA  
NAVAL STATION NEWPORT, RHODE ISLAND

DRAWN BY:	D.W.M. / R.G.D.	REV.:	0
CHECKED BY:	S. PARKER	DATE:	SEPTEMBER 25, 2003
SCALE:	1" = 100'	FILE NO.:	DWG\4152\0441\FIG_3-2.DWG

FIGURE 3-2



TETRA TECH NUS, INC.

55 Jonspin Road  
(978)658-7899  
Wilmington, MA 01887



In August 2002, all wells sampled were developed by high volume pumping to remove fines and sediments that had settled within and around the well screens since the sampling effort in 1997. Due to the recent occurrence of the development it is not believed that wells will require redevelopment for the monitoring effort. However, if non-turbid samples cannot be acquired using the methods described in this work plan, redevelopment of the wells may be necessary.

To maintain similarities to the previous sampling event and maximize comparability of data, low stress (low flow) sample collection procedures and peristaltic pumps will be used for the acquisition of groundwater samples, as summarized below. The U.S. EPA Region I SOP for low flow sample collection (SOP GW-0001, 7/30/96, Revision 2) is presented in Appendix A. This SOP will be followed, as practical, during the collection of groundwater samples. If the EPA method is unsuccessful in the collection of a groundwater sample, standard bailing techniques will be used.

The following steps provide a general guideline for the low flow groundwater sample collection:

1. The presence of floating product in the wells will be determined with the use of an immiscible liquid interface probe (or equivalent). The presence of product will be noted, and if appropriate, the thickness measured. The depth to water in the well will be measured and recorded to the nearest 0.01 feet, minimizing immersion of the meter within the standing water column to avoid disturbance of colloidal particles.
2. The required length of tubing will be calculated and measured for attachment to the peristaltic pump, such that the tubing intake is placed at the midpoint of the saturated screened interval. Note that the tubing will be measured to allow a minimum distance between the well head and the discharge point (field testing equipment) to minimize temperature changes in the groundwater discharged from the well. Teflon or teflon-lined tubing will be used and disposed of after sampling is complete.
3. The pump tubing will be slowly and smoothly lowered to the required depth to minimize the amount of mixing in the well. The pump's discharge tubing will be fastened to the well casing to minimize movement.
4. The field testing equipment and peristaltic pump head will be assembled and placed as close as possible to the well head/discharge tubing. The discharge tubing will be connected to the pump head with a minimum length of pharmaceutical grade silicone tubing.

5. The pump will be connected to the power supply (battery, generator or other power source) and the power supply turned on (without starting the pump).
6. The depth to water with the pump and/or tubing in the well will be re-measured with the water level indicator or interface probe and compared with the initial reading; if the readings vary by more than 0.05 feet, field personnel will wait five minutes, re-measure the water, and begin pumping.
7. The pump will be started at a low speed setting until discharge occurs. The pump start time will be recorded, the flow rate measured (adjusted as necessary to within acceptable limits), and recorded using a graduated measuring device and stopwatch. (Note that during the initial period of pumping, an estimated 5 to 10 minutes, the depth to water in the well should be measured frequently (at an estimated frequency of approximately once per minute), to enable timely pump flow adjustments to attempt to minimize significant drawdown in the well).
8. During well purging, purge water discharged from the tubing will be collected in a flow-through cell. Water quality parameters for pH, temperature, specific conductance, oxidation reduction potential (ORP), and dissolved oxygen will be measured during purging using a YSI model 600 XL water quality meter (or equivalent) and recorded. Turbidity will be measured using a LaMotte 2020 (or equivalent) meter from a sample aliquot that is collected before it reaches the flow-through cell. The sample aliquot will be collected using an in-line T-fitting and ball valve or similar device.
9. Water quality parameters (pH, temperature, specific conductance, oxygen reduction potential (ORP), turbidity, and dissolved oxygen) and the depth to water in the well will be measured at three to five-minute intervals as purging occurs. The data and the associated time will be recorded on the low-flow sampling data sheet. Attempts will be made to maintain the drawdown in the well during pumping to 0.3 feet or less, by adjusting the pump flow rate. Drawdown for each well will vary depending on the recharge capacity of the well.
10. Purging will continue until all of the parameters have stabilized. If stabilization of field parameters does not occur utilizing the low stress (low flow) procedure, the field crew will consult with the project manager, who will make the determination as whether to collect the sample or not. It is most likely that the sample will be collected and the data from that sample will have to be qualified with the information as to which parameters did not stabilize. "Stabilization" will be considered achieved when three consecutive readings are within the following limits:

- Turbidity (10% for values greater than 1 nephelometric turbidity units (NTU), as practical).
- Dissolved Oxygen (DO) (10%).
- Specific conductance (3%).
- Temperature (3%).
- pH ( $\pm 0.1$  unit).
- ORP/Eh ( $\pm 10$  millivolts)

Groundwater samples will be collected following the stabilization of the measured water quality parameters. The discharge tubing will be disconnected from the flow-through cell and the in-line device used to collect aliquots for separate turbidity measurements.

Samples will be collected directly through the discharge tubing into appropriate sample bottles. The sample aliquot for VOC analysis shall be collected directly into pre-preserved 40-mL amber vials with minimal disturbance. The bottles should be filled completely with no headspace remaining in the bottle. VOC samples shall not be opened after collection. An extra vial shall be collected initially to check the pH of the sample. If the desired pH is not obtained, five drops of hydrochloric acid (HCl) shall be placed into new 40-mL vials and the sample will be recollected. The process will be repeated until pH < 2 is achieved. The samples shall be recollected with the appropriate amount of HCl. If effervescence is noted when the samples are collected, the samples shall be recollected without preservative and shipped to the laboratory as soon as possible. Samples will be preserved according to requirements described in Table 3-3. All non-disposable sampling equipment will be decontaminated prior to each use, as described in Section 3.8. All pertinent sampling data will be recorded on appropriate sample log sheets and in the site logbook. Any field deviations shall be recorded on a Field Modification Record.

If difficulties arise during low stress (low flow) sample collection procedures (i.e. minimum drawdown is not obtainable; it can't be documented that the well is yielding fresh water despite the drawdown; or water chemistry readings do not show a stabilization pattern), affected wells may be sampled using standard bailing techniques. This change will constitute a field modification request as described elsewhere in this work plan.

Groundwater samples will be analyzed for VOCs, SVOCs, and metals (total). Appropriate chain-of-custody procedures will be followed and samples will be labeled, packaged, and shipped according to TtNUS SOP No. SA-6.1.

### **3.5                    LABORATORY ANALYSIS OF SAMPLES COLLECTED**

Table 3-2 presents a summary of field and QC samples, Table 3-3 presents the analytical methods, volume and preservatives required.

### **3.6                    INVESTIGATION-DERIVED WASTE (IDW) DISPOSAL**

Any IDW generated will be collected and stored in 5-gallon buckets for disposal off site. Chemical analysis for disposal parameters will be performed by the disposal contractor, if necessary, based on current restrictions and regulations. Any PPE waste generated during work will be decontaminated and stored in plastic bags for disposal at the end of each work day. The bags will be placed in an industrial dumpster at a location to be determined by the Navy.

### **3.7                    DECONTAMINATION PROCEDURES**

All non-disposable sampling equipment that comes in contact with the sample medium will be decontaminated to prevent cross-contamination between sampling points. This includes equipment such as sediment sampling spatulas, stainless steel bowls, scoops, split spoons, core samplers, etc. The following decontamination sequence will be employed:

- Remove gross contamination by scrubbing with potable water.
- Scrub with potable water/liquinox.
- Rinse with potable water.
- Rinse with deionized water.
- Rinse with 2-propanol.
- Air dry (to extent possible).
- Wrap with aluminum foil, dull side toward equipment.

## 4.0 QUALITY ASSURANCE/QUALITY CONTROL PLAN

This section provides technical guidelines and procedures for maintaining an appropriate level of quality for data collected during fieldwork performed. This section references the TtNUS Standard Operating Procedures (SOPs) for specific protocols for procedures discussed in Section 3.0. Pertinent SOPs and ASTM methods for fieldwork are included in this work plan as Appendix A. These SOPs include, but are not limited to:

<u>SOP</u>	<u>DESCRIPTION</u>
CT-04	Sample Nomenclature
CT-05	Database Records and Quality Assurance
SA-1.2	Surface Water and Sediment Sampling
SA-1.1	Groundwater Sample Acquisition and OnSite Water Quality Testing
SA-6.1	Non-Radiological Sample Handling
SA-6.3	Field Documentation
SA-7.1	Decontamination of Field Equipment and Waste Handling

In addition, a U.S. EPA SOP for groundwater sampling will also be used: U.S. EPA Region I SOP for low flow sample collection (SOP GW-0001, 7/30/96, Revision 2) as provided in Appendix A.

### 4.1 QUALITY ASSURANCE OBJECTIVES

The main objective of this round of environmental sampling is to provide sufficient data, when compared with existing data, to help determine ongoing condition of sediment and groundwater during the proposed soil removal action.

Achieving this objective requires that the data collected in the field conform to an appropriate level of quality. The quality of a data set is measured by certain characteristics of the data, namely the precision and accuracy, representativeness, completeness, and comparability (PARCC) parameters. Some of the parameters are expressed quantitatively, while others are expressed qualitatively. The PARCC goals for a particular project are determined by the intended use of the data, defined as a part of the Data Quality Objectives (DQOs). DQOs are discussed in Section 2.4; the PARCC parameters are discussed below.

#### 4.1.1 PARCC Parameters

The PARCC goals for the work covered by this quality assurance plan are discussed in the following sections.

#### **4.1.1.1 Precision and Accuracy**

Field and laboratory precision and accuracy performance can affect the attainment of project objectives, particularly when compliance with established criteria is based on laboratory analysis of environmental samples.

Field sampling precision and accuracy are not easily measured. Field contamination, sample preservation, and sample handling will affect precision and accuracy. By following the appropriate TtNUS SOP, precision and accuracy errors associated with field activities can be minimized. Field duplicates and blanks (field and rinsate) will be used to estimate field sampling precision and accuracy for samples submitted for laboratory analysis.

Field duplicate and field quality control blank analyses results will be used to review the laboratory-analyzed results and determine the usability of the data with respect to its intended use. As discussed in Section 2.4.6, the study was designed to have a relatively low tolerance for a false negative decision (i.e. sediment does not exceed PRGs, therefore no action necessary) and a high tolerance for a false positive decision (i.e., sediment exceeds PRGs, therefore station is considered for remedial action). As a result, it was determined that formal validation of the data would not be conducted to verify laboratory precision and accuracy.

#### **4.1.1.2 Representativeness**

Representativeness describes the degree to which analytical data accurately and precisely define the population being measured. Several elements of the sampling and sample handling process must be controlled to maximize the representativeness of the analytical data (appropriate number of samples collected, physical state of the samples, site-specific factors, sampling equipment, containers, sample preservation and storage, holding times, sample identity, and chain of custody). These elements are closely defined in this work plan and SOPs to ensure that the samples analyzed represent the population being measured). The sampling program is designed to provide analytical data that are representative of the existing contaminant levels.

Representativeness of data is also affected by sampling techniques. Errors or cross-contamination during the sampling could affect the laboratory analytical results. However, every effort will be made during sample collection to minimize the introduction of errors or cross-contamination by following the sample techniques described in Section 3.0, and in the TtNUS Standard Operating Procedures (SOPs) included in Appendix A.

**4.1.1.3 Completeness**

Completeness describes the amount of data generated that meets the objectives for precision, accuracy, and representativeness versus the amount of data expected to be obtained. For relatively clean, homogeneous matrices (such as water), 100 percent completeness is expected. However, as matrix complexity and heterogeneity increase (such as for sediment), completeness may decrease. The completeness objective for sediment during this monitoring program will be set at 95 percent. Where analysis is precluded or where data quality objectives are compromised, effects on the overall investigation must be considered. Whether or not any particular sample is critical to the investigation will ultimately be evaluated in terms of the sample location, the parameter in question, the intended data use, and the risk associated with the error.

The sampling and analysis program for the site is sufficiently broad in scope to prevent a single data point or parameter from jeopardizing attainment of the study objectives. Critical data points may not be identified until all the analytical results are evaluated. Additionally, several sampling points, in aggregate, may be considered to be critical either by location or by analysis. A subsequent sampling event may be necessary if it becomes apparent that the data for a specific medium are of insufficient quality, either with respect to the number of samples or based on an individual analysis.

For the purposes of this effort, a data point will be determined to contribute to the completeness of the data set if the information provided is meaningful, useful, and contributes to the project objectives.

**4.1.1.4 Comparability**

One of the objectives of the sampling effort is to provide analytical data that are characterized by a level of quality that is comparable between sampling points and sampling events. By specifying the use of standard analytical procedures (as well as standardizing field sampling procedures by employing TtNUS and others SOPs), the potential for variables to affect the final data quality will be effectively minimized. Analytical methods for this work are presented in Table 3-2; SOPs appear in Appendix A.

**4.1.2 Quality Control Samples**

QC samples to be used during the sampling effort are identified below, and include field duplicates or replicates, laboratory duplicates or replicates, rinsate blanks, field blanks, and source blanks. Each type of field quality control sample defined below will undergo the same preservation, holding times, etc., as the field samples. Table 3-1 presents a summary of the QC samples to be collected during this sampling event.

**4.1.2.1 Field Duplicates**

Field duplicates will be submitted at the rate of one for every ten samples per matrix. Field personnel will note on the sample summary form and in the logbook which samples are field duplicates. Duplicate samples will be shipped blind to the laboratories, and shipping paperwork will be completed accordingly.

Field duplicates are collected by mixing a double or triple portion of the required volume of sample and dividing it into two or three sample containers. Field duplicates provide precision information regarding homogeneity, handling, shipping, storing, preparation, and analysis.

**4.1.2.2 Rinsate Blanks**

Rinsate blanks are obtained under representative field conditions by running analyte-free deionized water through sample collection equipment after decontamination, immediately before sampling and placing it in the appropriate sample containers for analysis. These samples are used to assess the effectiveness of decontamination procedures. Rinsate blanks will be prepared at the rate of one per day during the sampling event. All rinsate samples will be sent to the laboratory, with instructions to the laboratory to "hold" every other sample (to be analyzed only if necessary based on results of previous rinsate blanks).

**4.1.2.3 Field Blanks**

Field blanks will consist of the source water used in decontamination (includes analyte-free deionized water, potable water from each source, and other waters used in decontamination operations). Field blanks will be prepared at the rate of one per source of water per sampling event.

**4.1.2.4 Matrix Spike/Matrix Spike Duplicates**

A matrix spike sample will be identified by field teams at a frequency of 1 in 20 field samples (per matrix) collected. Samples for matrix spike analyses and laboratory duplicate analysis are collected in triplicate volumes for aqueous organics (three containers for each analyte group), and duplicate volumes for aqueous metals (two containers). Soil matrix spikes will be collected in double volumes.

**4.2 PROJECT ACTION LIMITS AND METHOD DETECTION LIMITS**

Project Action Limits are provided in this section for laboratory analytical data to be collected during the monitoring effort at OFFTA.



The project action limits have been established based on the preliminary remediation goals (PRGs) provided in the Feasibility Study Report (TtNUS, September 2002) for groundwater and sediment. PRGs are risk based and regulatory based goals for removal actions for groundwater and sediment described in the Feasibility Study if those removal actions are determined to be necessary.

Tables 4-1 and 4-2 present the Project Action Limits for groundwater and sediment for the target analytes. These tables also present the detection limits and quantitation limits achievable through the methods specified in Section 3 of this work plan.

Sediment analysis performed for this site in the past has shown high variability in the laboratory quantitation limits. To compensate for this, target project quantitation limits have been set for sediment as one-tenth the Project Action Limits. Although the method planned is the best available method that could achieve these levels, some project quantitation limits are below the expected laboratory achievable quantitation limits. However, the project action limits are well above the quantitation limits so there is a factor of safety.

#### **4.3 SAMPLE DESIGNATION AND CUSTODY**

This section describes the sample designation and chain-of-custody requirements for all environmental and quality control samples.

##### **4.3.1 Environmental Samples**

Each sample collected will be assigned a unique sample tracking number that will be used to catalog the results in the Environmental Geographic Information System (EGIS) database system for NSN. The sample tracking number will consist of alpha-numeric characters identifying the site, sample medium, location, and depth. Any other pertinent information regarding sample identification will be recorded on the sample logsheets or in the field logbooks.

The alpha-numeric coding to be used in the sample system is detailed below and in the subsequent definitions.

AAA	-	AA	-	(NNN)	-	(NNNN)	-	(NN)
(Site ID)	-	(Medium)	-	(Location)	-	(Depth)	-	(Round)

Site identifier: "OFF" for OFFTA

**TABLE 4-1**  
**PROJECT ACTION LIMITS FOR SEDIMENT MONITORING**  
**DRAFT WORK PLAN FOR SEDIMENT AND GROUNDWATER MONITORING**  
**OLD FIRE FIGHTING TRAINING AREA**  
**NAVSTA NEWPORT, NEWPORT, RHODE ISLAND**

ANALYTES*	CAS NUMBER	PROJECT ACTION LIMIT (ug/kg) <sup>(1)</sup>	PROJECT QUANTITATION LIMIT <sup>(2)</sup>	Achievable Laboratory Limits	
				MDLs (ug/kg)	QLs (ug/kg)
2-Methylnaphthalene	91-57-6	185	19	0.56	20 <sup>(3)</sup>
Acenaphthylene	208-96-8	697	70	0.53	20 <sup>(3)</sup>
Benzo(a)anthracene	56-55-3	1338	134	1.01	20 <sup>(3)</sup>
Benzo(a)pyrene	50-32-8	134	13	0.75	20 <sup>(3)</sup>
Benzo(b)fluoranthene	205-99-2	1338	134	2.05	20 <sup>(3)</sup>
Dibenzo(a,h)anthracene	53-70-3	134	13	2	20 <sup>(3)</sup>
Indeno(1,2,3-cd)pyrene	193-39-5	5633	563	2.01	20 <sup>(3)</sup>
Arsenic	7440-38-2	6200	620	110	200 <sup>(4)</sup>

Notes:

\*Analytes are limited to selected PRGs and Contaminants of Concern from FS.

(1) Project Action limits are set as the lowest calculated PRG values for sediment calculated in the Feasibility Study (TtNUS Sept. 2002).

(2) Project Quantitation Limits are set as 10% of the project action limits to account for variability in the laboratory quantitation limits during analysis of sediment.

(3) The PAH compounds will be analyzed using SW846-8270 selected ion monitoring (SIM) which is the best available EPA - approved technology providing the lowest possible detection limits.

(4) Arsenic will be analyzed using SW-846-6020.

**TABLE 4-2**  
**PROJECT ACTION LIMITS FOR GROUNDWATER MONITORING**  
**DRAFT WORK PLAN FOR SEDIMENT AND GROUNDWATER MONITORING**  
**OLD FIRE FIGHTING TRAINING AREA**  
**NAVSTA NEWPORT, NEWPORT, RHODE ISLAND**

ANALYTES*	CAS NUMBER	PROJECT ACTION LIMIT (ug/kg) <sup>(1)</sup>	PROJECT QUANTITATION LIMIT <sup>(2)</sup>	Achievable Laboratory Limits	
				MDLs (ug/kg)	QLs (ug/kg)
VOLATILE ORGANIC COMPOUNDS					
Benzene	71-43-2	5	5	0.013	5
SEMIVOLATILE ORGANIC COMPOUNDS					
2-Methylnapthalene	91-57-6	128	0.2	0.08	0.2
Dibenzofuran	132-64-9	23	10	1.03	10
Napthalene	91-20-3	20	0.2	0.05	0.2
METALS					
Arsenic	7440-38-2	50	10	1.1	10
Barium	7440-39-3	2000	5	0.12	5
Cadmium	7440-43-9	5	5	0.28	5
Chromium	7440-47-3	100	15	0.57	15
Copper	7440-50-8	1300	25	0.91	25
Lead	7439-92-1	15	5	0.91	5
Manganese	7439-96-5	291	5	0.15	5
Vanadium	7440-62-2	81	25	0.36	25
Zinc	7440-66-6	4015	25	0.24	25

Notes:

NA means Not Applicable or Not Available.

\*Analytes are limited to contaminants of concern from the FS.

(1) Project Action limits are set as the lowest calculated PRG values for sediment calculated in the Feasibility Study (TtNUS Sept. 2002)

(2) Project Quantitation Limits for groundwater are acceptable as the laboratory quantitation limits.

Medium identifier: "SD" for sediment samples, GW for groundwater samples;

Sample location identifier: each sample location is a previous sample station, and will retain the original sample station designation.

Depth: This portion of the sample tracking number will represent the depth in inches below ground surface from which the sample was collected, e.g., for sediment samples collected from 0 to 6 inches below ground surface, this portion of the sample tracking number will be "0006", and samples collected from 12 to 18 inches below ground surface, the portion of the tracking number will be "1218", etc.

Round: This portion of the sample ID will designate the number of times the station has been sampled since the remedial investigation was completed for the site. All stations were sampled during the RI which constituted the "01" designation, and then again during the predesign investigation in 2001 or 2002, which constituted the 02 designation. Therefore the samples collected henceforth will be given a suffix of 03, 04 etc... as appropriate.

Examples:

The third sediment sample collected from boring number 412 at a depth of 0 to 6 inches will be identified as OFF-SD-412-0006-03.

#### Quality Control (QC) Samples

Field quality control (QC) samples will use the same coding system as for environmental samples. Field QC sample types are described in Section 4.1.2.

Blind duplicate samples will be designated such that the location designation will be replaced with a chronological number. The sample log sheet will note which sample location the duplicate was collected from:

Duplicates:                      OFF-DUP##

Field blanks will be designated such that they can clearly be identified as field blanks. The designation must be able to be referenced to the source, i.e. DIUF water, potable water (PTW), etc., using the field sample data forms.

Field Blanks:                      OFF-DIUF-FB##  
    OFF-PTW-FB##

Rinsate blanks will be identified using the code for the sample for which the sampling device or tool was last used, the identifier (RB), and its chronological number.

Rinsate Blanks:           OFF-SD-404-RB##

Matrix spike samples have no separate sample identifier codes, but are noted on the chain-of-custody record and sample logsheet.

#### **4.3.2           Sample Chain of Custody**

Custody of samples must be maintained and documented at all times. To ensure the integrity of a sample from collection through analysis, an accurate written record is necessary to trace the possession and handling of the sample. This documentation is referred to as the "chain of custody". Chain of custody begins when samples are collected in the field, and is maintained by storing the samples in secure areas until custody can be passed on. A chain-of-custody form that lists each sample, the analytical parameters, and the persons who are responsible for their integrity will accompany all samples (an example form is included in Appendix B).

Samples will be placed on ice and attended by TtNUS personnel or placed in locked vehicles or designated storage areas until analysis or shipment to an off-site laboratory. Chain-of-custody procedures are described in further detail in the SOPs.

#### **4.4           CALIBRATION PROCEDURES**

Field equipment normally requiring calibration will be calibrated and operated in accordance with the manufacturer's instructions and manuals. A log will be kept on site, documenting the periodic calibration results for each field instrument.

Calibration procedures for laboratory equipment used in the analysis of environmental samples will be performed in accordance with NFESC requirements and contract requirements under the Master Services Agreement (MSA).

#### **4.5           LABORATORY ANALYSIS**

Samples will be analyzed for various parameters as described in previous sections and in Table 3-1.

A laboratory previously approved by the Navy will analyze the environmental samples collected for laboratory analysis during the field investigation. Standard EPA analytical procedures as well as specialized analytical methods will be employed, as depicted in Table 3-2.

#### **4.6 DATA REDUCTION, VALIDATION, AND REPORTING**

Laboratory analytical data will be reviewed by qualified TtNUS technical staff. TtNUS will validate the analytical data at a Tier II level according to the EPA New England Data Validation Functional Guidelines for Evaluating Environmental Analyses.

The steps to be followed by TtNUS in the data validation process are as follows:

1. The FOL gives a copy of the chain-of-custody forms to the Lead Chemist. The Lead Chemist forwards a copy to a data entry person.
2. A Database Specialist creates a Microsoft Access (or equivalent) database for the project.
3. The data entry person inputs the information from the chain-of-custody records including the TtNUS sample location, date sampled, matrix, and QC type (e.g. blank, duplicate) into the database.
4. The Lead Chemist receives the data packages and electronic data deliverables from the subcontract laboratories. The data packages are logged into the Data Validation Tracking Log.
5. The Lead Chemist assigns a data validator for each data package and transfers the hard copy data packages.
6. The Lead Chemist gives the electronic data deliverables (EDD) to the database specialist.
7. The database specialist uploads the EDD into the project database using a TtNUS-developed file conversion program. The program identifies some common EDD problems (e.g., missing or incorrect SDG number, parameter naming issues) and provides an interface for their resolution. In some cases, queries are run against the EDD to find and fix minor errors. If the errors are serious, e.g. any error affecting the numerical results, the database specialist contacts the laboratory and requests a revised

EDD. The upload program checks to see if the incoming data has a corresponding sample number in the database from the chain-of-custody forms. If not, the incoming data is prevented from uploading. The upload program sequesters laboratory QC sample results in a separate table.

8. The database specialist prints a draft data validation table in Microsoft Excel format for distribution to the data validator.
9. The data validator checks the draft data validation tables against the data results (Form I's) in the data package and against the chain-of-custody records to ensure that the database matches the data package. The data validator notifies the database specialist immediately of any major problems (e.g., missing samples). In some cases, the database specialist may ask the laboratory to revise and resubmit the EDD.
10. The data validator performs the Tier I or Tier II validation, assessing potential data quality/usability issues, data completeness and writes the data validation report. The data validator marks up the draft data validation table and submits the complete data report to the Lead Chemist for review.
11. The Lead Chemist reviews the documents and returns them to the data validator for revision.
12. The data validator revises the documents and gives the marked-up draft data validation table to the database specialist.
13. The database specialist (or data entry person) revises the database and prints a final data validation table. The database specialist gives the final data validation table to the data validator along with the marked-up draft data validation table.
14. The data validator compares the final data validation table to the marked-up draft data validation table to make sure that all changes were incorporated into the database. The data validator assembles the data validation reports for approval and submits them for copying and distribution.

A data review memorandum will be prepared and submitted to the project manager as a part of that activity. Data review procedures are described in Section 4.10.

Field data will be periodically reviewed by technical lead personnel and the TtNUS PM to ensure that the data collected are well documented, clearly described, and meet a standard appropriate for the investigation and its ultimate use.

#### **4.7 INTERNAL QUALITY CONTROL**

Section 4.1.2 discussed the types and frequency of quality control samples that will be prepared during the field investigation activities for those samples that undergo laboratory analysis. The quantities of various types of QC samples are shown in Table 3-2. Laboratory analysis will follow the QC criteria described in the analytical procedures.

#### **4.8 PERFORMANCE AND SYSTEM AUDITS**

System audits will be performed as appropriate to ensure that the work is being implemented in accordance with the approved project SOPs and in an overall satisfactory manner.

- The TtNUS Field Operations Leader (FOL) will supervise and on a daily basis check to ensure that the equipment is properly decontaminated, samples are collected and handled properly, and the fieldwork is accurately and neatly documented.
- The data reviewer(s) will review the data to ensure they were obtained through the approved methodology, and that the appropriate level of QC effort and reporting were conducted. The data review effort will be supervised by the TtNUS CLEAN Quality Assurance Manager or designee.
- The Project Manager (PM) will oversee the FOL and data reviewer, and check that management of the acquired data proceeds in an organized and expeditious manner.

#### **4.9 PREVENTATIVE MAINTENANCE**

TtNUS has established a field equipment maintenance program to ensure the availability of equipment in good working order when and where it is needed. This program consists of the following elements:

- The equipment manager maintains an inventory of the equipment by model and serial number, quantity, and condition. Each item of equipment is signed out when in use and its operating condition and cleanliness is checked upon return.



- The equipment manager conducts routine checks on the status of equipment and is responsible for stocking spare parts and for equipment readiness.
- The equipment manager maintains the equipment manual library and trains field personnel in the proper use and care of equipment.
- The FOL is responsible for working with the equipment manager to ensure that the equipment is tested, cleaned, charged, and calibrated in accordance with the manufacturer's instructions before being taken to the job site.
- While the equipment is in the field, the FOL or designee is responsible for the equipment, maintains calibration records, and performs maintenance operations and checks.

#### **4.10 DATA ASSESSMENT PROCEDURES**

The following paragraphs describe the procedures used to evaluate data prior to inclusion in deliverable reports.

##### **4.10.1 Representativeness, Accuracy, and Precision**

All laboratory data generated in the investigation will be assessed for representativeness, accuracy, and precision, as described in Section 4.1. The completeness of the data will also be assessed by comparing the acquired data to the project objectives to see that these objectives are being addressed and met.

Qualified TtNUS personnel will conduct the PARCC parameter assessment. Determining if the data are consistent with known or anticipated chemical conditions and accepted principles will assess the representativeness of the data.

Field measurements will be checked for completeness of procedures and documentation of procedures and results.

Precision and accuracy will be determined using duplicate samples, and blank and spiked samples, respectively. PARCC parameters are addressed in more detail in Section 4.1.

**4.10.2      Analytical Data Review**

An analytical data review process that includes the following tasks will be carried out:

- Check data for completeness to determine if all samples were analyzed and reported for the parameters requested in the chain-of-custody form.
- Check data report for accuracy of sample identification, sample location, collection date, and units.
- Organize the data tables by sample matrix, sample location, and calculate and report the average of field duplicate results. Consolidate results of two sample dilutions into one set of results.
- Check large positive hits against the raw data to avoid false positive results.
- Submit the data review results with a summary of problems and resolutions in writing.

**4.11              CORRECTIVE ACTION**

The QA program will enable problems to be identified, controlled, and corrected. Potential problems may involve non-conformance with the SOPs and/or analytical procedures established for the project, or other unforeseen difficulties. Any person identifying an unacceptable condition will notify the FOL and the PM. The PM, with the assistance of the Quality Assurance Manager and the project QA/QC officer, will be responsible for developing and initiating appropriate corrective action and verifying that the corrective action has been effective.

Corrective actions may include re-sampling and/or re-analysis of samples or modifying project procedures. If warranted by the severity of the problem (for example, if a change in the approved work plan is required), the Navy will be notified in writing and their approval will be obtained prior to implementing any change. Additional work that depends on a nonconforming activity will not be performed until the source of the problem has been addressed.

**4.12              QUALITY ASSURANCE REPORTS/DOCUMENTS**

A bound/weatherproof field logbook will be maintained by the FOL. The FOL or designee will record all information related to sampling or field activities. This information may include sampling time, weather conditions, unusual events, field measurements, photograph description, etc. The site logbook

maintained by the FOL will contain a summary of the day's activities and will reference the other field logbooks when applicable.

At the completion of field activities, the FOL will submit to the PM all field records, data, field logbooks, chain-of-custody receipts, sample logsheets, etc. The PM will ensure that these materials are entered into the project file. Examples of forms to be used in the field are included in Appendix B.

**5.0 REPORTING**

A report on the findings of the monitoring effort will be prepared which will describe sampling procedures, and data collected. The report will include photos taken of each sample station, and a map showing previous and current PRG exceedances, superimposed on the ecologically sensitive areas mapped in the summer of 2001 and updated as described in this work plan. A possible outline of the Monitoring Report is provided below:

1. Executive Summary
2. Introduction
3. Background
  - Summary of RI and FS
  - Summary of Predesign Investigation
4. Summary of Investigations
  - Procedures for sampling
  - Sample locations
5. Findings of the Investigations
  - Eelgrass survey update
  - Data results from chemical analysis of sediment
  - Results from forensic analysis of sediment
  - Data results from chemical analysis of groundwater
  - Data summary tables, compared with previous results
  - Mapped PRG exceedances
6. Summary and Conclusions

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## REFERENCES

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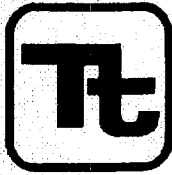
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**APPENDIX A**  
**STANDARD OPERATING PROCEDURES**





TETRA TECH NUS, INC.

# STANDARD OPERATING PROCEDURES

Number

CT-04

Page

1 of 6

Effective Date

09/03

Revision

1

Applicability

Tetra Tech NUS, Inc.

Prepared

Risk Assessment Department

Subject

SAMPLE NOMENCLATURE

Approved

D. Senovich

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## 1.0 PURPOSE

The purpose of this document is to specify a consistent sample nomenclature system that will facilitate subsequent data management in a cost-effective manner. The sample nomenclature system has been devised such that the following objectives can be attained:

- Sorting of data by matrix.
- Sorting of data by depth.
- Maintenance of consistency (field, laboratory, and data base sample numbers).
- Accommodation of all project-specific requirements.
- Accommodation of laboratory sample number length constraints (maximum of 20 characters).

## 2.0 SCOPE

The methods described in this procedure shall be used consistently for all projects requiring electronic data.

## 3.0 GLOSSARY

None.

## 4.0 RESPONSIBILITIES

**Program Manager** - It shall be the responsibility of the Program Manager (or designee) to inform contract-specific Project Managers of the existence and requirements of this Standard Operating Procedure.

**Project Manager** - It shall be the responsibility of the Project Manager to determine the applicability of this Standard Operating Procedure based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the sample nomenclature is thoroughly specified in the relevant project planning document (e.g., sampling and analysis plan) and is consistent with this Standard Operating Procedure if relevant. It shall be the responsibility of the project manager to ensure that the Field Operations Leader is familiar with the sample nomenclature system.

**Field Operations Leader** - It shall be the responsibility of the Field Operations Leader to ensure that all field technicians or sampling personnel are thoroughly familiar with this Standard Operating Procedure and the project-specific sample nomenclature system. It shall be the responsibility of the Field Operations Leader to ensure that the sample nomenclature system is used during all project-specific sampling efforts.

## 5.0 PROCEDURES

### 5.1 Introduction

The sample identification (ID) system can consist of as few as 8 but not more than 20 distinct alpha-numeric characters. The sample ID will be provided to the laboratory on the sample labels and chain-of-custody forms. The basic sample ID provided to the lab has three segments and shall be as follows where "A" indicates "alpha," and "N" indicates "numeric":

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters
Site Identifier	Sample Type	Sample Location

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Additional segments may be added as needed. For example:

- (1) Soil and Sediment Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	NNNN 4-Characters
Site Identifier	Sample Type	Sample Location	Sample Depth

- (2) Aqueous (groundwater or surface water) Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	NN 2-Characters	-A
Site Identifier	Sample type	Sample Location	Round Number	Filtered Sample only

- (3) Biota Sample ID

A or N 3- or 4-Characters	AAA 2- or 3-Characters	A or N 3- to 6-Characters	AA 2-Characters	NNN 3-Characters
Site Identifier	Sample Type	Sample Location	Species Identifier	Sample Group Number

## 5.2 Sample Identification Field Requirements

The various fields in the sample ID will include but are not limited to the following:

- Site Identifier
- Sample Type
- Sample Location
- Sample Depth
- Sampling Round Number
- Filtered
- Species Identifier
- Sample Group Number

The site identifier must be a three- or four-character field (numeric characters, alpha characters, or a mixture of alpha and numeric characters may be used). A site number is necessary since many facilities/sites have multiple individual sites, SWMUs, operable units, etc. Several examples are presented in Section 5.3 of this SOP.

The sample type must be a two- or three-character alpha field. Suggested codes are provided in Section 5.3 of this SOP.

The sample location must be at least a three-character field but may have up to six-characters (alpha, numeric, or a mixture). The six-characters may be useful in identifying a monitoring well to be sampled or describing a grid location.

The sample depth field is used to note the depth below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval in feet bgs of the sample. If the sample depth is equal to or greater than 100, then only the top interval would be represented and the sampling depth would be truncated to

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three-characters. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc.

A two-digit round number will be used to track the number of aqueous samples taken from a particular aqueous sample location. The first sample collected from a location will be assigned the round identifier 01, the second 02, etc. This applies to both existing and proposed monitoring wells and surface water locations.

Aqueous samples that are field filtered (dissolved analysis) will be identified with an "-F" in the last field segment. No entry in this segment signifies an unfiltered (total) sample.

The species identifier must be a two-character alpha field. Several suggested codes are provided in Section 5.3 of this SOP.

The three digit sample group number will be used to track the number of biota sample groups (a particular group size may be determined by sample technique, media type, the number of individual caught, weight issues, time, etc.) by species and location. The first sample group of a particular species collected from a given location will be assigned the sample group number 001 and the second sample group of the same species collected from the same location will be assigned the sample group number 002.

### 5.3 Example Sample Field Designations

Examples of each of the fields are as follows:

Site Identifier - Examples of site numbers/designations are as follows:

- A01 - Area of Concern Number 1
- 125 - Solid Waste Management Unit Number 125
- 000 - Base or Facility Wide Sample (e.g., upgradient well)
- BBG - Base Background

The examples cited are only suggestions. Each Project Manager (or designee) must designate appropriate (and consistent) site designations for their individual project.

Sample Type - Examples of sample types are as follows:

- AH - Ash Sample
- AS - Air Sample
- BM - Building Material Sample
- BSB - Biota Sample Full Body
- BSF - Biota Sample Fillet
- CP - Composite Sample
- CS - Chip Sample
- DS - Drum Sample
- DU - Dust Sample
- FP - Free Product
- IDW - Investigation Derived Waste Sample
- LT - Leachate Sample
- MW - Monitoring Well Groundwater Sample
- OF - Outfall Sample
- RW - Residential Well Sample
- SB - Soil Boring Sample
- SD - Sediment Sample
- SC - Scrape Sample

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SG - Soil Gas Sample  
 SL - Sludge Sample  
 SP - Seep Sample  
 SS - Surface Soil Sample  
 ST - Storm Sewer Water Sample  
 SW - Surface Water Sample  
 TP - Test Pit Sample  
 TW - Temporary Well Sample  
 WC - Well Construction Material Sample  
 WP - Wipe Sample  
 WS - Waste/Solid Sample  
 WW - Wastewater Sample

Sample Location - Examples of the location field are as follows:

001 - Monitoring Well 1  
 N32E92 - Grid location 32 North and 92 East  
 D096 - Investigation derived waste drum number 96

Species Identifier - Examples of species identifier are as follows:

BC - Blue Crab  
 GB - Blue Gill  
 CO - Corn  
 SB - Soybean

#### 5.4 Examples of Sample Nomenclature

The first round monitoring well groundwater sample collected from existing monitoring well 001 at SWMU 16 for a filtered sample would be designated as 016MW00101-F.

The second round monitoring well groundwater sample collected from existing monitoring well C20P2 at Site 23 for an unfiltered sample would be designated as 023MWC20P202.

The second surface water sample collected from point 01 at SWMU 130 for an unfiltered sample would be designated as 130SW00102.

A surface soil sample collected from grid location 32 North and 92 East at Site 32 at the 0- to 2-foot interval would be designated as 032SSN32E920002.

A subsurface soil sample from soil boring 03 at SWMU 32 at an interval of 4 to 5 feet bgs would be designated as 032SB0030405.

A sediment sample collected at SWMU 19 from 0 to 6 inches at location 14 would be designated as 019SD0140001. The sample data sheet would reflect the precise depth at which this sample was collected.

During biota sampling for full body analysis the first time a minnow trap was checked at grid location A25 of SWMU 1415 three small blue gills were captured, collected and designated with the sample ID of 1415BSBA25BG001. The second time blue gill were collected at the same location (grid location A25 at SWMU 1415) the sample ID designation given was 1415BSBA25BG002.

Note: No dash (-) or spacing is used between the segments with the exception of the filtered segment. The "F" used for a filtered aqueous sample is preceded by a dash "-F".

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### 5.5 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature

Field QA/QC will be designated using a different coding system. The QC code will consist of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

AA	NNNNNN	NN	-F
QC Type	Date	Sequence Number (per day)	Filtered (aqueous only, if needed)

The QC types are identified as:

TB = Trip Blank  
 RB = Rinsate Blank (Equipment Blank)  
 FD = Field Duplicate  
 AB = Ambient Conditions Blank  
 WB = Source Water Blank

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the routine sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory). Documentation for all other QC types (TB, RB, AB, and WB) will be recorded on the QC Sample Log sheet (see SOP on Field Documentation).

### 5.6 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day for a filtered ground water sample collected on June 3, 2000 would be designated as FD06030001-F.

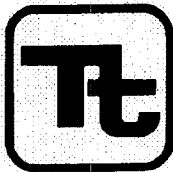
The third duplicate of the day taken of a subsurface soil sample collected on November 17, 2003 would be designated as FD11170303.

The first trip blank associated with samples collected on October 12, 2000 would be designated as TB10120001.

The only rinsate blank collected on November 17, 2001 would be designated as RB11170101.


### 6.0 **DEVIATIONS**

Any deviation from this SOP must be addressed in detail in the site specific planning documents.



**TETRA TECH NUS, INC.**

# STANDARD OPERATING PROCEDURES

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Applicability	Tetra Tech NUS, Inc.		
Prepared	Management Information Systems Department		
Approved	D. Senovich 		

Subject  
DATABASE RECORDS AND QUALITY ASSURANCE

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## 1.0 PURPOSE

The purpose of this document is to specify a consistent procedure for the quality assurance review of electronic and hard copy databases. This SOP outlines the requirements for establishment of a Database Record File, Quality Assurance review procedures, and documentation of the Quality Assurance Review Process.

## 2.0 SCOPE

The methods described in this Standard Operating Procedure (SOP) shall be used consistently for all projects managed by Tetra Tech NUS (TtNUS).

## 3.0 GLOSSARY

Chain-of-Custody Form - A Chain-of-Custody Form is a printed form that accompanies a sample or a group of samples from the time of sample collection to the laboratory. The Chain-of-Custody Form is retained with the samples during transfer of samples from one custodian to another. The Chain-of-Custody Form is a controlled document that becomes part of the permanent project file. Chain-of-Custody and field documentation requirements are addressed in SOP SA-6.1.

Electronic Database - A database provided on a compact laser disk (CD). Such electronic databases will generally be prepared using public domain software such as DBase, RBase, Oracle, Visual FoxPro, Microsoft Access, Paradox, etc.

Hardcopy Database - A printed copy of a database prepared using the software discussed under the definition of an electronic database.

Form 1 - A printed copy of the analytical results for each sample.

Sample Tracking Summary - A printed record of sample information including the date the samples were collected, the number of samples collected, the sample matrix, the laboratory to which the samples were shipped, the associated analytical requirements for the samples, the date the analytical data were received from the laboratory, and the date that validation of the sample data was completed.

## 4.0 RESPONSIBILITIES

Database Records Custodian - It shall be the responsibility of the Database Records Custodian to update and file the Sample Tracking Summaries for all active projects on a weekly basis. It shall be the responsibility of the Database Records Custodian to ensure that the most recent copies of the Sample Tracking Summaries are placed in the Database Records file. It shall be the responsibility of the Database Records Custodian to ensure that a copy of all validation deliverables is provided to the Project Manager (for placement in the project file). It shall be the responsibility of the Database Records Custodian to ensure that photocopies of all validation deliverables and historical data and reports (as applicable) are placed in the Database Records file.

Data Validation Coordinator - It shall be the responsibility of the Data Validation Coordinator (or designee) to ensure that the Sample Tracking Summaries are maintained by the Database Records Custodian. It shall be the responsibility of the Data Validation Coordinator (or designee) to ensure that photocopies of all data validation deliverables are placed in the applicable Database Records file by the Database Records Custodian.



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**Earth Sciences Department Manager** - It shall be the responsibility of the Earth Sciences Department Manager (or equivalent) to ensure that all field personnel are familiar with the requirements of this Standard Operating Procedure (specifically Section 5.5).

**FOL** - It shall be the responsibility of the FOL (FOL) of each project to ensure that all field technicians or sampling personnel are thoroughly familiar with this SOP, specifically regarding provision of the Chain-of-Custody Forms to the Database Records Custodian. Other responsibilities of the FOL are described in Sections 5.4 and 5.5.

**Management Information Systems (MIS) Manager** - It shall be the responsibility of the MIS Manager to ensure that copies of original electronic deliverables (CDs) are placed in both the project files and the Database Records File. It shall be the responsibility of the MIS Manager (or designee) to verify the completeness of the database (presence of all samples) in both electronic and hardcopy form in the Database Records File. It shall be the responsibility of the MIS Manager to ensure that Quality Assurance Reviews are completed and are attested to by Quality Assurance Reviewers. It shall be the responsibility of the MIS Manager to ensure that records of the Quality Assurance review process are placed in the Database Records File. It shall be the responsibility of the MIS Manager to ensure that both electronic and hardcopy forms of the final database are placed in both the project and the Database Record File. It shall be the responsibility of the MIS Manager to ensure that data validation qualifiers are entered in the database.

Furthermore, it shall be the responsibility of the MIS Manager to participate in project planning at the request of the Project Manager, specifically with respect to the generation of level of effort and schedule estimates. To support the project planning effort, the MIS Manager shall provide a copy of the MIS Request Form included as Attachment A to the project manager. It shall be the responsibility of the MIS Manager to generate level of effort and budget estimates at the time database support is requested if a budget does not exist at the time of the request. The MIS Request Form shall be provided to the Project Manager at the time of any such requests. It shall be the responsibility of the MIS Manager to notify the Project Manager of any anticipated level of effort overruns or schedule noncompliances as soon as such problems arise along with full justification for any deviations from the budget estimates (provided they were generated by the MIS Manager). It shall be the responsibility of the MIS Manager to document any changes to the scope of work dictated by the Project Manager, along with an estimate of the impact of the change on the level of effort and the schedule.

**Program/Department Managers** - It shall be the responsibility of the Department and/or Program Managers (or designees) to inform their respective department's Project Managers of the existence and requirements of this SOP.

**Project Manager** - It shall be the responsibility of each Project Manager to determine the applicability of this SOP based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the FOL is familiar with the requirements regarding Chain-of-Custody Form provision to the Database Records Custodian. It shall be the responsibility of the Project Manager (or designee) to determine which, if any, historical data are relevant and to ensure that such data (including all relevant information such as originating entity, sample locations, sampling dates, etc.) are provided to the Database Records Custodian for inclusion in the Database Records File. It shall be the responsibility of the Project Manager to obtain project planning input regarding the level of effort and schedule from the MIS Manager. It shall be the responsibility of the Project Manager to complete the database checklist (Attachment A) to support the level of effort and schedule estimate and to facilitate database preparation and subroutine execution.

**Risk Assessment Department Manager** - It shall be the responsibility of the Risk Assessment Department Manager to monitor compliance with this Standard Operating Procedure, to modify this SOP as necessary, and to take corrective action if necessary. Monitoring of the process shall be completed on a quarterly basis.

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**Quality Assurance Reviewers** - It shall be the responsibility of the Quality Assurance Reviewers to verify the completeness of the sample results via review of the Chain-of-Custody Forms and Sample Tracking Summaries. It shall be the responsibility of the Quality Assurance Reviewers to ensure the correctness of the database via direct comparison of the hardcopy printout of the database and the hardcopy summaries of the original analytical data (e.g., Form Is provided in data validation deliverables). Correctness includes the presence of all relevant sample information (all sample information fields), agreement of the laboratory and database analytical results, and the presence of data validation qualifiers.

**Quality Manager** - It shall be the responsibility of the Quality Manager to monitor compliance with this Standard Operating Procedure via routine audits.

## 5.0 PROCEDURES

### 5.1 Introduction

Verification of the accuracy and completeness of an electronic database can only be accomplished via comparison of a hardcopy of the database with hardcopy of all relevant sample information. The primary purposes of this SOP are to ensure that 1) all necessary hardcopy information is readily available to Quality Assurance Reviewers; 2) ensure that the Quality Assurance review is completed in a consistent and comprehensive manner, and; 3) ensure that documentation of the Quality Assurance review process is maintained in the project file.

### 5.2 File Establishment

A Database Record file shall be established for a specific project at the discretion of the Project Manager. Initiation of the filing procedure will commence upon receipt of the first set of Chain-of-Custody documents from a FOL or sampling technician. The Database Record Custodian shall establish a project-specific file for placement in the Database Record File. Each file in the Database Record File shall consist of standard components placed in the file as the project progresses. Each file shall be clearly labeled with the project number, which shall be placed on the front of the file drawer and on each and every hanging file folder relevant to the project. The following constitute the minimum components of a completed file:

- Electronic Deliverables
- Sample Tracking Forms
- Chain-of-Custody Forms
- Data Validation Letters
- Quality Assurance Records

### 5.3 Electronic Deliverables

The format of electronic deliverables shall be specified in the laboratory procurement specification and shall be provided by the laboratory. The integrity of all original electronic data deliverables shall be maintained. This shall be accomplished via the generation of copies of each electronic deliverable provided by the laboratory. The original electronic deliverable shall be provided to the project manager for inclusion in the project file. A copy of the original electronic deliverable shall be placed in the Database Record File. The second copy shall be maintained by the MIS Manager (or designee) to be used as a working copy.

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#### 5.4 Sample Tracking Forms

Updated versions of the sample tracking form for each relevant project shall be maintained by the Database Record Custodian. The Sample Tracking Forms shall be updated any time additional Chain-of-Custody Forms are received from a FOL or sampling technician, or at any time that data are received from a laboratory, or at any time that validation of a given data package (sample delivery group) is completed. The Data Validation Coordinator shall inform the Database Record Custodian of the receipt of any data packages from the laboratory and of completion of validation of a given data package to facilitate updating of the Sample Tracking Form. The Database Record Custodian shall place a revised copy of the Sample Tracking Form in the Database Record File anytime it has been updated. Copies of the updated Sample Tracking Form shall also be provided to the project manager to apprise the project manager of sample package receipt, completion of validation, etc.

#### 5.5 Chain-of-Custody Forms

The Chain-of-Custody Forms for all sampling efforts will be used as the basis for (1) updating the Sample Tracking Form, and (2) confirming that all required samples and associated analyses have been completed. It shall be the responsibility of the FOL (or sample technician) to provide a photocopy of all Chain-of-Custody Forms to the Database Record Custodian immediately upon completion of a sampling effort. The Database Record Custodian shall then place the copies of the Chain-of-Custody Form(s) in the Database Record File. Upon receipt of a sample data package from an analytical laboratory, the Data Validation Coordinator shall provide a copy of the laboratory Chain-of-Custody Form to the Database Record Custodian. The Database Record Custodian shall use this copy to update the Sample Tracking Summary and shall place the copy of the laboratory-provided Chain-of-Custody Form in the Database Record File. The photocopy of the laboratory-provided Chain-of-Custody Form shall be stapled to the previously filed field copy. Upon receipt of all analytical data, two copies of the Chain-of-Custody will therefore be in the file. Review of the Chain-of-Custody Forms will therefore be a simple mechanism to determine if all data have been received. Chain-of-Custody is addressed in SOP SA-6.1.

#### 5.6 Data Validation Letters

All data validation deliverables (or raw data summaries if validation is not conducted) shall be provided for inclusion in both the Database Record File and the project file. If USEPA regional- or client-specific requirements are such that Form 1s (or similar analytical results) need not be provided with the validation deliverable, copies of such results must be appended to the deliverable. It is preferable, although not essential that the validation qualifiers be hand-written directly on the data summary forms. The data validation deliverables (and attendant analytical summaries) will provide the basis for direct comparison of the database printout and the raw data and qualifiers.

#### 5.7 Historical Data

At the direction of the Project Manager, historical data may also be included in a project-specific analytical database. In the event that historical data are germane to the project, hardcopy of the historical data must be included in the Database Record File. Historical data may be maintained in the form of final reports or as raw data. The information contained in the historical data file must be sufficient to identify its origin, its collection date, the sample location, the matrix, and any and all other pertinent information. All available analytical data, Chain-of-Custody Forms, boring logs, well construction logs, sample location maps, shall be photocopied by the Project Manager (or designee) and placed in one or more 3-ring binders. All information shall be organized chronologically by matrix. It shall be the responsibility of the Project Manager (or designee) to ensure that all inconsistencies between analytical data, Chain-of-Custody Forms, boring logs, sample log sheets, and field logbooks are identified and corrected. The Project Manager (or designee) shall decide which nomenclature is appropriate and edit, initial and date all relevant forms. Data entry may only be performed on information that has undergone the aforementioned

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editing process, thereby having a direct correlation between hardcopy information and what will become the electronic database.

## 6.0 RECORDS

Records regarding database preparation and quality assurance review include all those identified in the previous section. Upon completion of the database task, records from the file will be forwarded to the Project Manager for inclusion in the project file, or will be placed in bankers boxes (or equivalent) for storage. The final records for storage shall include the following minimum information on placards placed on both the top and end of the storage box:

Database Record File  
PROJECT NUMBER: \_\_\_\_\_  
SITE NAME: \_\_\_\_\_  
DATE FILED: \_\_/\_\_/\_\_  
SUMMARY OF CONTENTS ENCLOSED  
BOX \_ OF \_

Project- or program-specific record keeping requirements shall take precedence over the record keeping requirements of this SOP.

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01/29/01

## ATTACHMENT A



## MIS REQUEST FORM

Tetra Tech NUS, Inc.

Project Name:	Request Date:
CTO:	Date Data Available for Production:
Project Manager:	Request in Support of:
Requestor:	Database Lead:
Program/Client:	GIS Lead:
State/EPA Region:	Statistics Lead:
	Risk Lead:

Site Name(s) (Area, OU, etc.):

Sampling Date(s):

Matrix: ☐ GW ☐ SO ☐ SD ☐ SW ☐ Other:Labels: ☐ Labels needed for an upcoming sampling event ☐ Total # of Samples

Estimated Hours

Due Date

Additional Instructions:

Complete ETS Charge No.

FOL

## Data Entry:

- ☐ Chemical data needs to be entered from hardcopy ☐ Estimated # of Samples
- ☐ Chemical data needs to be formatted electronically
- ☐ Field analytical data needs to be entered from hardcopy
- ☐ Geologic data needs to be entered from hardcopy
- ☐ Hydrology data needs to be entered from hardcopy

Estimated Hours

Due Date

Additional Instructions:

Complete ETS Charge No.

## Tables:

- ☐ Full Data Printout
- ☐ Summary of Positive Hits
- ☐ Occurrence and Distribution ☐ with criteria
- ☐ Sampling Analytical Summary
- ☐ Other:

Estimated Hours

Due Date

Additional Instructions:

Complete ETS Charge No.

## GIS:

- ☐ General Facility Location
- ☐ Site Location
- ☐ Potentiometric Contours/Groundwater Flow
- ☐ Sample Location Proposed
- ☐ Sample Location Existing
- ☐ Tag Map Single Round
- ☐ Tag Map Multiple Round
- ☐ Isoconcentrations
- ☐ Chart Map
- ☐ 3D Visualization
- ☐ EGIS CD
- ☐ Other:

Estimated Hours

Due Date

Additional Instructions:

Complete ETS Charge No.

## Statistics:

☐ Yes

Estimated Hours

Due Date

Additional Instructions:

Complete ETS Charge No.

## Geostatistics:

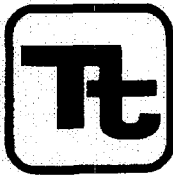
☐ Yes

Estimated Hours

Due Date

Additional Instructions:

Complete ETS Charge No.



**TETRA TECH NUS, INC.**

# STANDARD OPERATING PROCEDURES

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Applicability	Tetra Tech NUS, Inc.		
Prepared	Earth Sciences Department		
Approved	D. Senovich <i>ds</i>		

Subject  
SURFACE WATER AND SEDIMENT SAMPLING

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## **1.0 PURPOSE**

This procedure describes methods and equipment commonly used for collecting environmental samples of surface water and aquatic sediment for either onsite examination and chemical testing, or for subsequent laboratory analysis.

## **2.0 SCOPE**

The information presented in this guideline is generally applicable to all environmental sampling of surface waters (Section 5.3) and aquatic sediments (Section 5.5), except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions and equipment different from those described herein.

## **3.0 GLOSSARY**

Environmental Sample - a sample containing (or suspected to contain) low-level concentrations of contaminants, which does not require special handling or transport considerations as detailed in SOP SA-6.1.

Hazardous Waste Sample - a sample containing (or suspected to contain) higher concentrations of contaminants thus requiring special handling and/or transport considerations per SOP SA-6.1.

## **4.0 RESPONSIBILITIES**

Project Manager - The Project Manager has the overall responsibility for seeing that all surface water and sediment sampling activities are properly conducted by appropriately trained personnel.

Field Operations Leader - The Field Operations Leader (FOL) is responsible for the supervision of onsite water quality analyses, ensuring proper sample collection, handling, and the completion and accuracy of all field documentation, and making sure that custody of all samples obtained is maintained according to proper procedures.

## **5.0 PROCEDURES**

### **5.1 Introduction**

Collecting a representative sample from surface water or sediments is difficult because of water movement, stratification, or patchiness. To collect representative samples, one must standardize sampling bias related to site selection, sampling frequency, sample collection, sampling devices, and sample handling, preservation, and identification.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important characteristic not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been taken. Regardless of quality control applied during laboratory analyses and subsequent scrutiny of analytical data packages, reported data are no better than the confidence that can be placed in the representativeness of the samples.

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## **5.2      Defining the Sampling Program**

Many factors must be considered in developing a sampling program for surface water or sediments including study objectives, accessibility, site topography, physical characteristics of the water body (such as flow and mixing), point and diffuse sources of contamination, and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depends on bottom current or flow characteristics, sediment characteristics (density, size) and geochemical properties (which affect adsorption/desorption). The hydrogeologist developing the sampling plan must therefore know not only the mixing characteristics of streams and lakes, but also must understand the role of fluvial-sediment transport, deposition, and chemical sorption.

### **5.2.1      Sampling Program Objectives**

The objective of surface water sampling is to determine the surface water quality entering, leaving or remaining within the site. The scope of the sampling program must consider the sources and potential pathways for transport of contamination to or within a surface water body. Sources may include point sources (leaky tanks, outfalls, etc.) or nonpoint sources (e.g., spills). The major pathways for surface water contamination (not including airborne deposition) are overland runoff, leachate influx to the waterbody, direct waste disposal (solid or liquid) into the water body; and groundwater flow influx from upgradient. The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) which encompass the site, and the history of site activities.

Physiographic and hydrologic features to be considered include slopes and runoff direction, areas of temporary flooding or pooling, tidal effects, artificial surface runoff controls such as berms or drainage ditches (and when they were constructed relative to site operation), and locations of springs, seeps, marshes, etc. In addition, the obvious considerations such as the location of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, estuary, etc., shall be considered.

A more subtle consideration in designing the sampling program is the potential for dispersion of dissolved or sediment-associated contaminants away from the source. The dispersion could lead to a more homogeneous distribution of contamination at low or possibly non-detectable concentrations. Such dispersion does not, however, always readily occur. For example, obtaining a representative sample of contamination from a main stream immediately below an outfall or a tributary is difficult because the inflow frequently follows a stream bank with little lateral mixing for some distance. Sampling alternatives to overcome this situation are: (1) move the site far enough downstream to allow for adequate mixing, or (2) collect integrated samples in a cross section. Also, nonhomogeneous distribution is a particular problem with regard to sediment-associated contaminants, which may accumulate in low-energy environments (coves, river bends, deep spots, or even behind boulders) near or distant from the source while higher-energy areas (main stream channels) near the source may show no contaminant accumulation.

The distribution of particulates within a sample itself is an important consideration. Many organic compounds are only slightly water soluble and tend to adsorb onto particulate matter. Nitrogen, phosphorus, and the heavy metals may also be transported by particulates. Samples must be collected with a representative amount of suspended material; transfer from the sampling device shall include transferring a proportionate amount of the suspended material.

### **5.2.2      Location of Sampling Stations**

Accessibility is the primary factor affecting sampling costs. The desirability and utility of a sample for analysis and consideration of site conditions must be balanced against the costs of collection as controlled



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by accessibility. Bridges or piers are the first choice for locating a sampling station on a stream, because bridges provide ready access and also permit the sampling technician to sample any point across the stream. A boat or pontoon (with an associated increase in cost) may be needed to sample locations on lakes and reservoirs, as well as those on larger rivers. Frequently, however, a boat will take longer to cross a water body and will hinder manipulation of the sampling equipment. Wading for samples is not recommended unless it is known that contaminant levels are low so that skin contact will not produce adverse health effects. This provides a built in margin of safety in the event that wading boots or other protective equipment should fail to function properly. If it is necessary to wade into the water body to obtain a sample, the sampler shall be careful to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If necessary, the sampling technician shall wait for the sediments to settle before taking a sample.

Sampling in marshes or tidal areas may require the use of an all-terrain vehicle (ATV). The same precautions mentioned above with regard to sediment disturbance apply.

Under ideal and uniform contaminant dispersion conditions in a flowing stream, the same concentrations of each would occur at all points along the cross section. This situation is most likely downstream of areas of high turbulence. Careful site selection is needed in order to ensure, as nearly as possible, that samples are taken where uniform flow or deposition and good mixing conditions exist.

The availability of streamflow and sediment discharge records can be an important consideration in choosing sampling sites in streams. Streamflow data in association with contaminant concentration data are essential for estimating the total contaminant loads carried by the stream. If a gaging station is not conveniently located on a selected stream, the project hydrogeologist shall explore the possibility of obtaining streamflow data by direct or indirect methods.

### **5.2.3 Frequency of Sampling**

The sampling frequency and the objectives of the sampling event will be defined by the project plan documents. For single-event site or area characterization sampling, both bottom material and overlying water samples shall be collected at the specified sampling stations. If valid data are available on the distribution of the contaminant between the solid and aqueous phases, it may be appropriate to sample only one phase, although this is not often recommended. If samples are collected primarily for monitoring purposes (i.e., consisting of repetitive, continuing measurements to define variations and trends at a given location), water samples shall be collected at a pre-established and constant interval as specified in the project plans (often monthly or quarterly, and during droughts and floods). Samples of bottom material shall be collected from fresh deposits at least yearly, and preferably seasonally, during both spring and fall.

The variability in available water-quality data shall be evaluated before determining the number and collection frequency of samples required to maintain an effective monitoring program.

## **5.3 Surface Water Sample Collection**

### **5.3.1 Streams, Rivers, Outfalls and Drainage Features (Ditches, Culverts)**

Methods for sampling streams, rivers, outfalls, and drainage features at a single point vary from the simplest of hand-sampling procedures to the more sophisticated multi-point sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (see below).

Samples from different depths or cross-sectional locations in the watercourse taken during the same sampling episode, shall be composited. However, samples collected along the length of the watercourse or at different times may reflect differing inputs or dilutions and therefore shall not be composited.

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Generally, the number and type of samples to be taken depend on the river's width, depth, discharge and on the suspended sediment the stream or river transports. The greater the number of individual points that are sampled, the more likely that the composite sample will truly represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling site can generally be found where the water is well mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross section.

For larger streams, at least one vertical composite shall be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. The measurement of DO, pH, temperature, conductivity, etc., shall be made on each aliquot of the vertical composite and on the composite itself. For rivers, several vertical composites shall be collected, as directed in the project plan documents.

### **5.3.2 Lakes, Ponds and Reservoirs**

Lakes, ponds, and reservoirs have a much greater tendency to stratify than rivers and streams. The relative lack of mixing requires that more samples be obtained.

The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, the measurement of DO, pH, temperature, etc., is to be conducted on each aliquot of the vertical composite and on the composite itself. In naturally-formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites shall be composited to form a single sample. These verticals are often taken along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the thermocline which is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer which is only mixed with the epilimnion and vented to the atmosphere during seasonal "overtum" (when density stratification disappears). These two zones may thus have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite consists of several verticals with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately represent water quality since it is likely that only poor mixing will occur. Similarly, additional samples are recommended where discharges, tributaries, land use characteristics, and other such factors are suspected of influencing water quality.

Many lake measurements are now made in-situ using sensors and automatic readout or recording devices. Single and multi-parameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential (ORP), specific conductance, dissolved oxygen, some cations and anions, and light penetration.

### **5.3.3 Estuaries**

Estuarine areas are by definition, zones where inland freshwaters (both surface and ground) mix with oceanic saline waters. Estuaries are generally categorized into three types dependent upon freshwater inflow and mixing properties. Knowledge of the estuary type is necessary to determine sampling locations. Each type of estuarine area is described below:

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- **Mixed Estuary** - characterized by the absence of a vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is shallow and is found in major freshwater sheetflow areas. Being well mixed, the sampling locations are not critical in this type of estuary.
- **Salt Wedge Estuary** - characterized by a sharp vertical increase in salinity and stratified freshwater flow along the surface. In these estuaries, the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.
- **Oceanic Estuary** - characterized by salinities approaching full-strength oceanic waters. Seasonally, freshwater inflow is small with the preponderance of the fresh-saline water mixing occurring near, or at, the shore line.

Sampling in estuarine areas is normally based upon the tidal phases, with samples collected on successive slack tides (i.e., when the tide turns). Estuarine sampling programs shall include vertical salinity measurements at 1- to 5-foot increments, coupled with vertical dissolved oxygen and temperature profiles.

#### **5.3.4 Surface Water Sampling Equipment**

The selection of sampling equipment depends on the site conditions and sample type to be acquired. The most frequently used samplers are:

- Open tube.
- Dip sampler.
- Weighted bottle.
- Hand pump.
- Kemmerer.
- Depth-Integrating Sampler.

The dip sampler and the weighted bottle sampler are used most often, and detailed discussions for these devices only (and the Kemmerer sampler) are addressed subsequently in this section.

The criteria for selecting a sampler include:

1. Disposability and/or easy decontamination.
2. Inexpensive cost (if the item is to be disposed).
3. Ease of operation.
4. Nonreactive/noncontaminating properties - Teflon-coated, glass, stainless-steel or PVC sample chambers are preferred (in that order).

As specified above, each sample (grab or each aliquot collected for compositing) shall be measured for but not limited to:

- Specific conductance.
- Temperature.
- pH.
- Dissolved oxygen (optional).

Sample measurements shall be conducted as soon as the sample is acquired. Measurement techniques described in SOP SA-1.1 shall be followed. All pertinent data and results shall be recorded in a field

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notebook or on sample logsheets (see Attachment A). These analyses will provide information on water mixing/stratification and potential contamination.

#### Dip Sampling

Water is often sampled by filling a container either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Constituents measured in grab samples are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration that is distributed throughout the water column and in the cross section. Therefore, whenever possible, it is recommended to augment dip samples with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

#### Weighted Bottle Sampling

A grab sample can also be taken using a weighted holder that allows a bottle to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of a stopped glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle. The procedure for sampling with this device is:

- Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).
- Pull out the stopper with a sharp jerk of the stopper line.
- Allow the bottle to fill completely, as evidenced by the absence of air bubbles.
- Raise the sampler and cap the bottle.
- Decontaminate the outside of the bottle. This bottle can be used as the sample container as long as the bottle is an approved container type.

#### Kemmerer

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon coated sampler, a standard Kemmerer sampler may be used. The Kemmerer sampler is a brass, stainless-steel or acrylic cylinder, with rubber stoppers that leave the ends open while being lowered in a vertical position (thus allowing free passage of water through the cylinder). A "messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles.

#### **5.3.5 Surface Water Sampling Techniques**

Most samples taken during site investigations are grab samples. Typically, surface water sampling involves immersing the sample container in the body of water; however, the following suggestions are made to help ensure that the samples obtained are representative of site conditions:

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- The most representative samples are obtained from mid-channel at a 0.6 foot stream depth in a well-mixed stream.
- Even though the containers used to obtain the samples are previously laboratory cleaned, it is suggested that the sample container be rinsed at least once with the water to be sampled before the sample is taken. This is not applicable when sample containers are provided "pre-preserved."
- For sampling moving water, it is suggested that the farthest downstream sample be obtained first, and that subsequent samples be taken as one works upstream. In general, work from zones suspected of low contamination to zones of high contamination.
- To sample a pond or other standing body of water, the surface area may be divided into grids. A series of samples taken from each grid node is combined into one sample, or several grid nodes are selected at random.
- Care should be taken to avoid excessive agitation of the water, as loss of volatile constituents could result.
- When obtaining samples in 40 mL septum vials for volatile organics analysis, it is important to exclude any air space in the top of the bottle and to be sure that the Teflon liner of the septum faces in after the vial is filled and capped. The vial can be turned upside down to check for air bubbles.
- Do not sample at the surface, unless sampling specifically for a known constituent which is immiscible and on top of the water. Instead, the sample container should be inverted, lowered to the approximate depth, and held at about a 45-degree angle with the mouth of the bottle facing upstream. When sample containers are provided "pre-preserved," use a dedicated, clean, un-preserved bottle for sampling and transfer to an appropriately-preserved container.

#### **5.4      Onsite Water Quality Testing**

Onsite water quality testing shall be conducted as described in SOP SA-1.1.

#### **5.5      Sediment Sampling**

##### **5.5.1      General**

Sediment samples are usually collected at the same verticals at which water samples were collected. If only one sediment sample is to be collected, the sampling location shall be approximately at the center of the water body.

Generally, the coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center of a water body will be composed of fine-grained materials which may, because of their lower porosity and greater surface area available for adsorption, contain greater concentrations of contaminants. The shape, flow pattern, bathymetry (i.e., depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (e.g., bends, behind islands or boulders, quiet shallow areas or very deep, low-velocity areas) shall be sampled while areas likely to show net erosion (i.e., high-velocity, turbulent areas) and suspension of fine solid materials, shall be avoided.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom samples reflect the historical input to streams, lakes, and estuaries with respect to time, application of chemicals, and land use. Bottom sediments (especially fine-grained material) may act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if

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water column concentrations are below detection limits). Therefore, it is important to minimize the loss of low-density "fines" during any sampling process.

All relevant information pertaining to sediment sampling shall be documented as applicably described in SOP SA-6.3 and Attachment B.

### **5.5.2 Sampling Equipment and Techniques**

A bottom-material sample may consist of a single scoop or core, or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using onshore or offshore techniques.

The following health and safety provisions apply when working on/over/near water.

Size of Work Team:

- 1) Never less than 2 persons [who are wearing USCG approved Personal Flotation Devices (PFDs)]
- 2) A minimum of 3 persons if any of the following conditions are anticipated or observed:
  - Depth is greater than 3 feet
  - Involves a waterway that is turbulent or swift
  - The underwater walking surface (e.g., stream/river bed) is suspected or observed to involve conditions that increase the potential for a worker to fall into the water. Examples would include large/uneven rocks or boulders, dense mud or sediment that could entrap worker's feet, etc.)
  - Waterway is tidal, and conditions such as those listed above could change

The third person in the above condition must be equipped and prepared to render emergency support [e.g., lifeline, tethered PFD (life saver), skiff, means to contact external emergency response support, etc.]

The following samplers may be used to collect bottom materials:

- Scoop sampler.
- Dredge samplers.

Each type of sampler is discussed subsequently.

#### **Scoop Sampler**

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood, PVC, or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest and best way to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping the sampler along the bottom in an upstream direction. It is very difficult not to disturb fine-grained materials of the sediment-water interface when using this method.



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### Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices (i.e., coarse-grained or partially-cemented materials) or when large quantities of sample are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a "messenger". Some dredges are heavy and may require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman and Ponar dredges.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The Peterson dredge shall be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave". The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates.

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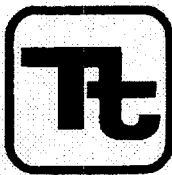
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**TETRA TECH NUS, INC.**

# STANDARD OPERATING PROCEDURES

Number

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5

Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Subject

GROUNDWATER SAMPLE ACQUISITION AND  
ONSITE WATER QUALITY TESTING

Approved

D. Senovich

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## **1.0 PURPOSE**

The purpose of this procedure is to provide general reference information regarding the sampling of groundwater wells.

## **2.0 SCOPE**

This procedure provides information on proper sampling equipment, onsite water quality testing, and techniques for groundwater sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require modifications to methodology.

## **3.0 GLOSSARY**

Conductivity – Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, and relative concentrations, and on temperature of measure. Conductivity is highly dependent on temperature and should be reported at a particular temperature, i.e., 20.2 mS/cm at 14°C.

Dissolved Oxygen (DO) – DO levels in natural and wastewater depend on the physical, chemical, and biochemical activities in the water sample.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode, immersed in water, as referenced against a standard hydrogen electrode.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

pH Paper - Indicator paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution's pH.

Salinity – The measurement of dissolved salts in a given mass of solution. Note: most field meters determined salinity automatically from conductivity and temperature. The displayed value will be displayed in either parts per thousand (ppt) or % (e.g., 35 ppt will equal 3.5%).

Turbidity – Turbidity in water is caused by suspended matter, such as clay, silt, fine organic and inorganic matter. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample.

## **4.0 RESPONSIBILITIES**

Project Hydrogeologist - Responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), and equipment to be used, and providing detailed input in this regard to the project plan documents. The project hydrogeologist is also responsible for properly briefing and overseeing the performance of the site sampling personnel.

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Project Geologist/Field Sample Technician - is primarily responsible for the proper acquisition of the groundwater samples. He/she is also responsible for the actual analyses of onsite water quality samples, as well as instrument calibration, care, and maintenance. When appropriate, such responsibilities may be performed by other qualified personnel (e.g., field technicians).

## **5.0 PROCEDURES**

### **5.1 General**

To be useful and accurate, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of analysis in order to keep any changes in water quality parameters to a minimum.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach shall be followed prior to sample acquisition:

1. All monitoring wells shall be purged prior to obtaining a sample. Evacuation of three to five volumes is recommended prior to sampling. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, extensive evacuation prior to sample withdrawal is not as critical.
2. For wells that can be purged dry, the well shall be evacuated and allowed to recover to 75% full capacity prior to sample acquisition. If the recovery rate is fairly rapid, evacuation of more than one volume of water is required.
3. For high-yielding monitoring wells which cannot be evacuated to dryness, there is no absolute safeguard against contaminating the sample with stagnant water. One of the following techniques shall be used to minimize this possibility:
  - A submersible pump or the intake line of a surface pump or bailer shall be placed just below the water surface when removing the stagnant water and lowered as the water level drops. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. Once this is accomplished, a bailer or other approved device may be used to collect the sample for analysis.
  - The intake line of the sampling pump (or the submersible pump itself) unless otherwise directed shall be placed near the center of the screened section, and approximately one casing volume of water shall be pumped from the well at a low purge rate, equal to the well's recovery rate (low flow sampling).

Stratification of contaminants may exist in the aquifer. Concentration gradients as a result of mixing and dispersion processes, layers of variable permeability, and the presence of separate-phase product (i.e.,

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floating hydrocarbons) may cause stratification. Excessive pumping or improper sampling methods can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column as it naturally occurs at that point, thus the result is the collection of a non-representative sample.

## **5.2 Sampling, Monitoring, and Evacuation Equipment**

Sample containers shall conform with the guidelines expressed in SOP SA-6.1.

The following equipment shall be on hand when sampling groundwater wells (reference SOPs SA-6.1 and SA-7.1):

- Sample packaging and shipping equipment - Coolers for sample shipping and cooling, chemical preservatives, appropriate sampling containers and filler, ice, labels and chain-of-custody documents.
- Field tools and instrumentation - Multi-parameters water quality meter capable of measuring ORP, pH, temperature, DO, specific conductance, turbidity and salinity or individual meters (as applicable), pH paper, camera and film (if appropriate), appropriate keys (for locked wells), water level indicator.
- Pumps
  - Shallow-well pumps: Centrifugal, bladder, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing) where applicable.
  - Deep-well pumps: Submersible pump and electrical power-generating unit, or bladder pumps where applicable.
- Other sampling equipment - Bailers and inert line with tripod-pulley assembly (if necessary).
- Pails - Plastic, graduated.
- Decontamination solutions - Deionized water, potable water, laboratory detergents, 10% nitric acid solution (as required), and analytical-grade solvent (e.g., pesticide-grade isopropanol), as required.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, cleaned prior to use, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well purging and sample collection.

## **5.3 Calculations of Well Volume**

To insure that the proper volume of water has been removed from the well prior to sampling it is first necessary to know the volume of standing water in the well pipe. This volume can be easily calculated by the following method. Calculations shall be entered in the site logbook or field notebook or on a sample log sheet form (see SOP SA-6.3):

- Obtain all available information on well construction (location, casing, screens, etc.).
- Determine well or inner casing diameter.
- Measure and record static water level (depth below ground level or top of casing reference point).
- Determine depth of well by sounding using a clean, decontaminated, weighted tape measure.

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- Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

- Calculate one static well volume in gallons  $V = (0.163)(T)(r^2)1$

where: V = Static volume of well in gallons.  
T = Thickness of water table in the well measured in feet (i.e., linear feet of static water).  
r = Inside radius of well casing in inches.  
0.163 = A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.

- Per evacuation volumes discussed above, determine the minimum amount to be evacuated before sampling.

#### 5.4 Evacuation of Static Water (Purging)

##### 5.4.1 General

The amount of purging a well shall receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately the well can be pumped until the parameters such as temperature, specific conductance, pH, and turbidity (as applicable), have stabilized. Onsite measurements of these parameters shall be recorded in the site logbook, field notebook, or on standardized data sheets.

##### 5.4.2 Evacuation Devices

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment A provides guidance on the proper evacuation device to use for given sampling situations. Note that all of these techniques involve equipment which is portable and readily available.

##### Bailers

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of pipe with a sealed bottom (bucket-type bailer) or, as is more useful and favored, with a ball check-valve at the bottom. An inert line is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

- Few limitations on size and materials used for bailers.
- No external power source needed.
- Bailers are inexpensive, and can be dedicated and hung in a well to reduce the chances of cross-contamination.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:



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- It is time consuming to remove stagnant water using a bailer.
- Transfer of sample may cause aeration.
- Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

#### Suction Pumps

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, and peristaltic pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause significant loss of dissolved gases and volatile organics.

#### Air-Lift Samplers

This group of pump samplers uses gas pressure either in the annulus of the well or in a venturi to force the water up a sampling tube. These pumps are also relatively inexpensive. Air (or gas)-lift samplers are more suitable for well development than for sampling because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation, or loss of volatile organics.

#### Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch-diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- They may have low delivery rates.
- Many models of these pumps are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding the impellers with some of these pumps.
- Decontamination of internal components can be difficult and time-consuming.

### **5.5      Onsite Water Quality Testing**

This section describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen (DO)
- Oxidation-Reduction Potential (ORP)

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- Turbidity
- Salinity

This section is applicable for use in an onsite groundwater quality monitoring program to be conducted at a hazardous or nonhazardous site. The procedures and equipment described are applicable to groundwater samples and are not, in general, subject to solution interferences from color, turbidity, and colloidal material or suspended matter.

This section provides general information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use. Most meters used to measure field parameters require calibration on a daily basis. Refer to SOP 6.3 for example equipment calibration log.

### **5.5.1 Measurement of pH**

#### **5.5.1.1 General**

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required, and the pH meter when a more accurate measurement is needed. The response of a pH meter can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

#### **5.5.1.2 Principles of Equipment Operation**

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or alkalinity of the solution created by the addition of the water sample reacting with the indicator compound on the paper. Various types of pH papers are available, including litmus (for general acidity or alkalinity determination) and specific pH range hydron paper.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to (in this instance, hydrogen) ion concentration across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to the ion concentration is generated and measured.

#### **5.5.1.3 Equipment**

The following equipment is needed for taking pH measurements:

- Stand-alone portable pH meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).



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- Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs).
- Buffer solutions, as specified by the manufacturer.
- pH indicator paper, to cover the pH range 2 through 12.
- Manufacturer's operation manual.

#### 5.5.1.4 Measurement Techniques for Field Determination of pH

##### pH Meter

The following procedure is used for measuring pH with a pH meter (meter standardization is according to manufacturer's instructions):

- Inspect the instrument and batteries prior to initiation of the field effort.
- Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.
- If applicable, make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
- Calibrate on a daily use basis (or as recommended by manufacturer) following manufacturer's instructions. Record calibration data on an equipment calibration log sheet.
- Immerse the electrode(s) in the sample. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.
- Read and record the pH of the sample. pH shall be recorded to the nearest 0.01 pH unit. Also record the sample temperature.
- Rinse the electrode(s) with deionized water.
- Store the electrode(s) in an appropriate manner when not in use.

Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted.

##### pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper and proceed with successively narrower range paper until the sample pH is adequately determined.

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## **5.5.2 Measurement of Specific Conductance**

### **5.5.2.1 General**

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance. Most conductivity meters in use today display specific conductance (SC); units of milliSiemens per centimeter, which is the conductivity normalized to temperature @ 25°C. This format (SC) is the required units recorded on the groundwater sample log field form (Attachment B).

### **5.5.2.2 Principles of Equipment Operation**

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, while the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not dissociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

### **5.5.2.3 Equipment**

The following equipment is needed for taking specific conductance (SC) measurements:

- Stand alone portable conductivity meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

A variety of conductivity meters are available which may also be used to monitor salinity and temperature. Probe types and cable lengths vary, so equipment must be obtained to meet the specific requirement of the sampling program.

### **5.5.2.4 Measurement Techniques for Specific Conductance**

The steps involved in taking specific conductance measurements are listed below (standardization is according to manufacturer's instructions):

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- Check batteries and calibrate instrument before going into the field.
- Calibrate on a daily use basis (or as recommended by manufacturer), according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet. Potassium chloride solutions with a SC closest to the values expected in the field shall be used for calibration.
- Rinse the cell with one or more portions of the sample to be tested or with deionized water.
- Immerse the electrode in the sample and measure the conductivity.
- Read and record the results in a field logbook or sample log sheet.
- Rinse the electrode with deionized water.

If the specific conductance measurements become erratic, recalibrate the instrument and see the manufacturer's instructions for details.

### **5.5.3 Measurement of Temperature**

#### **5.5.3.1 General**

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

#### **5.5.3.2 Equipment**

Temperature measurements may be taken with alcohol-toluene, mercury filled, dial-type thermometers or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).. In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

#### **5.5.3.3 Measurement Techniques for Water Temperature**

If a thermometer is used to determine the temperature for a water sample:

- Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of cross-contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.
- Record values in a field logbook or sample log sheet.

If a temperature meter or probe is used, the instrument shall be calibrated according to manufacturer's recommendations.

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#### **5.5.4 Measurement of Dissolved Oxygen**

##### **5.5.4.1 General**

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time if the sample is not adequately preserved.

The monitoring method discussed herein is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible, and is not susceptible to interference caused by color, turbidity, colloidal material or suspended matter.

##### **5.5.4.2 Principles of Equipment Operation**

Dissolved oxygen probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH<sup>-</sup>) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, while leaving the surface of the solution undisturbed.

Dissolved oxygen probes are relatively unaffected by interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide, which are not easily depolarized from the indicating electrode. If a gaseous interference is suspected, it shall be noted in the field log book and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer.

##### **5.5.4.3 Equipment**

The following equipment is needed to measure dissolved oxygen concentration:

- Stand alone portable dissolved oxygen meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Sufficient cable to allow the probe to contact the sample.
- Manufacturer's operation manual.

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#### 5.5.4.4 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure the dissolved oxygen concentration:

- The equipment shall be calibrated and have its batteries checked before going to the field.
- The probe shall be conditioned in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
- The instrument shall be calibrated in the field according to manufacturer's recommendations or in a freshly air-saturated water sample of known temperature.
- Record all pertinent information on an equipment calibration sheet.
- Rinse the probe with deionized water.
- Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane by stirring the sample. Probes without stirrers placed in wells can be moved up and down.
- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.
- Rinse the probe with deionized water.
- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This however, may not always be practical.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

#### 5.5.5 **Measurement of Oxidation-Reduction Potential**

##### 5.5.5.1 General

The oxidation-reduction potential (ORP) provides a measure of the tendency of organic or inorganic compounds to exist in an oxidized state. The ORP parameter therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of oxidized to reduced species in the sample.

##### 5.5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and is dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental

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measurements, such as dissolved oxygen, may be correlated with ORP to provide a knowledge of the quality of the solution, water, or wastewater.

#### 5.5.5.3 Equipment

The following equipment is needed for measuring the oxidation-reduction potential of a solution:

- Combination meters with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Reference solution as specified by the manufacturer.
- Manufacturer's operation manual.

#### 5.5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring oxidation-reduction potential:

- The equipment shall be checked using the manufacturer's recommended reference solution and have its batteries checked before going to the field.
- Thoroughly rinse the electrode with deionized water.
- If the probe does not respond properly to the recommended reference solution, then verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of a test solution is altered. The ORP will increase when the pH of a test solution decreases, and the ORP will decrease if the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added (i.e., pH is raised) thus indicating the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions or the probe should be replaced.
- Record all pertinent information on an equipment calibration log sheet.

### 5.5.6 **Measurement of Turbidity**

#### 5.5.6.1 General

Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample. Turbidity in water is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and microscopic organisms, including plankton.

It is important to obtain a turbidity reading immediately after taking a sample, since irreversible changes in turbidity may occur if the sample is stored too long.

#### 5.5.6.2 Principles of Equipment Operation

Turbidity is measured by the Nephelometric Method. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the scattered light intensity, the higher the turbidity.

Formazin polymer is used as the reference turbidity standard suspension because of its ease of preparation combined with a higher reproducibility of its light-scattering properties than clay or turbid

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natural water. The turbidity of a specified concentration of formazin suspension is defined as 40 nephelometric units. This same suspension has an approximate turbidity of 40 Jackson units when measured on the candle turbidimeter. Therefore, nephelometric turbidity units (NTU) based on the formazin preparation will approximate units derived from the candle turbidimeter but will not be identical to them.

#### 5.5.6.3 Equipment

The following equipment is needed for turbidity measurement:

- Light meter (e.g., LaMotte 2020) which calibrates easily using test cells with standards of 0.0 NTUs, and 10 NTUs, or combination meter (e.g., Horiba U-10), or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

#### 5.5.6.4 Measurement Techniques for Turbidity

The steps involved in taking turbidity measurements utilizing an electrode (e) or light meter (l) are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instrument before going into the field.
- Check the expiration date (etc.) of the solutions used for field calibration.
- Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet.
- Rinse the electrode with one or more portions of the sample to be tested or with deionized water (applies to "e").
- Fill the light meters glass test cell with ~5 ml of sample, screw on cap, wipe off glass, place test cell in light meter and close the lid (applies to "l").
- Immerse the electrode in the sample and measure the turbidity (applies to "e").
- The reading must be taken immediately as suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.
- Read and record the results in a field logbook or sample log sheet. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.
- Rinse the electrode or test cell with deionized water.

#### 5.5.7 Measurement of Salinity

##### 5.5.7.1 General

Salinity is a unitless property of industrial and natural waters. It is the measurement of dissolved salts in a given mass of solution. Note: Most field meters determined salinity automatically from conductivity and



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temperature. The displayed value will be displayed in either parts per thousand (ppt) or % (e.g., 35 ppt will equal 3.5%).

**5.5.7.2      Principles of Equipment Operation**

Salinity is determined automatically from the meter's conductivity and temperature readings according to algorithms (found in *Standard methods for the Examination of Water and Wastewater*). Depending on the meter, the results are displayed in either ppt or %. The salinity measurements are carried out in reference to the conductivity of standard seawater (*corrected to S = 35*).

**5.5.7.3      Equipment**

The following equipment is needed for Salinity measurements:

- Multi-parameter water quality meter capable of measuring conductive, temperature and converting them to salinity (e.g., Horiba U-10 or YSI 600 series).
- Calibration Solution, as specified by the manufacturer.
- Manufacturer's operation manual.

**5.5.7.4      Measurement Techniques for Salinity**

The steps involved in taking Salinity measurements are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate before going into the field.
- Check the expiration date (etc.) of the solutions used for field calibration.
- Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet.
- Rinse the cell with the sample to be tested.
- Immerse the multi-probe in the sample and measure the salinity. Read and record the results in a field logbook or sample log sheet.
- Rinse the probes with deionized water.

**5.6              Sampling**

**5.6.1              Sampling Plan**

The sampling approach consisting of the following, shall be developed as part of the project plan documents which are approved prior to beginning work in the field:

- Background and objectives of sampling.
- Brief description of area and waste characterization.
- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).

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- Intended number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.
- Sample preservation requirements.
- Work schedule.
- List of team members.
- List of observers and contacts.
- Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

**5.6.2 Sampling Methods**

The collection of a groundwater sample consists of the following steps:

1. The site Health & Safety Officer (or designee) will first open the well cap and use volatile organic detection equipment (PID or FID) on the escaping gases at the well head to determine the need for respiratory protection.
2. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data on a groundwater sampling log sheet (see Attachment B); then calculate the fluid volume in the well pipe (as previously described in this SOP).
3. Calculate well volume to be removed as stated in Section 5.3.
4. Select the appropriate purging equipment (see Attachment A). If an electric submersible pump with packer is chosen, go to Step 10.
5. Lower the purging equipment or intake into the well to a short distance below the water level and begin water removal. Collect the purged water and dispose of it in an acceptable manner (as applicable). Lower the purging device, as required, to maintain submergence.
6. Measure the rate of discharge frequently. A graduated bucket or cylinder and stopwatch are most commonly used.
7. Observe the peristaltic pump intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics.
8. Purge a minimum of three to five casing volumes before sampling. In low-permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Purged water shall be collected in a designated container and disposed in an acceptable manner.
9. If sampling using a pump, lower the pump intake to midscreen (or the middle of the open section in uncased wells) and collect the sample. If sampling with a bailer, lower the bailer to just below the water surface.

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10. (For pump and packer assembly only). Lower the assembly into the well so that the packer is positioned just above the screen or open section. Inflate the packer. Purge a volume equal to at least twice the screened interval (or unscreened open section volume below the packer) before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.
11. In the event that recovery time of the well is very slow (e.g., 24 hours or greater), sample collection can be delayed until the following day. If the well has been purged early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record this occurrence in the site logbook.
12. Fill sample containers (preserve and label as described in SOP SA-6.1).
13. Replace the well cap and lock as appropriate. Make sure the well is readily identifiable as the source of the samples.
14. Process sample containers as described in SOP SA-6.1.
15. Decontaminate equipment as described in SOP SA-7.1.

## **5.7 Low Flow Purging and Sampling**

### **5.7.1 Scope & Application**

Low flow purging and sampling techniques are sometimes required for groundwater sampling activities. The purpose of low flow purging and sampling is to collect groundwater samples that contain "representative" amounts of mobile organic and inorganic constituents in the vicinity of the selected open well interval, at or near natural flow conditions. The minimum stress procedure emphasizes negligible water level drawdown and low pumping rates in order to collect samples with minimal alterations in water chemistry. This procedure is designed primarily to be used in wells with a casing diameter of 1 inch or more and a saturated screen, or open interval, length of ten feet or less. Samples obtained are suitable for analyses of common types of groundwater contaminants (volatile and semi-volatile organic compounds, pesticides, PCBs, metals and other inorganic ions [cyanide, chloride, sulfate, etc.]). This procedure is not designed to collect non-aqueous phase liquids samples from wells containing light or dense non-aqueous phase liquids (LNAPLs or DNAPLs), using the low flow pumps.

The procedure is flexible for various well construction types and groundwater yields. The goal of the procedure is to obtain a turbidity level of less than 10 NTU and to achieve a water level drawdown of less than 0.3 feet during purging and sampling. If these goals cannot be achieved, sample collection can take place provided the remaining criteria in this procedure are met.

### **5.7.2 Equipment**

The following equipment is required (as applicable) for low flow purging and sampling:

- Adjustable rate, submersible pump (e.g., centrifugal or bladder pump constructed of stainless steel or Teflon).
- Disposable clear plastic bottom filling bailers may be used to check for and obtain samples of LNAPLs or DNAPLs.

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- Tubing - Teflon, Teflon-lined polyethylene, polyethylene, PVC, Tygon, or stainless steel tubing can be used to collect samples for analysis, depending on the analyses to be performed and regulatory requirements.
- Water level measuring device, 0.01 foot accuracy, (electronic devices are preferred for tracking water level drawdown during all pumping operations).
- Interface probe, if needed.
- Flow measurement supplies.
- Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.
- Indicator parameter monitoring instruments - pH, turbidity, specific conductance, and temperature. Use of a flow-through cell is recommended. Optional Indicators - ORP, salinity, and dissolved oxygen, flow-through cell is required. Standards to perform field calibration of instruments.
- Decontamination supplies.
- Logbook(s), and other forms (see Attachments B and C).
- Sample Bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags and/or labels.
- Well construction data, location map, field data from last sampling event (if available).
- Field Sampling Plan.
- PID or FID instrument for measuring VOCs (volatile organic compounds).

**5.7.3 Purging and Sampling Procedure**

Open monitoring well, measure head space gases using PID/FID. If there is an indication of off gassing when opening the well, wait 3-5 minutes to permit water level an opportunity to reach equilibrium.

Measure and record the water level immediately prior to placing the pump in the well.

Lower pump or tubing slowly into the well so that the pump intake is located at the center of the saturated screen length of the well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of sediment that may be present in the bottom of the well. Collection of turbidity-free water samples may be difficult if there is three feet or less of standing water in the well.

Start with the initial pump rate set at approximately 0.1 liters/minute. Use a graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary to prevent drawdown from exceeding 0.3 feet during purging. If no drawdown is noted, the pump rate may be increased (to a max of 0.4 liters/minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If groundwater is drawn down below

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the top of the well screen, purging will cease or the well will be pumped to dryness and the well will be allowed to recover before purging continues. Slow recovering wells will be identified and purged at the beginning of the workday. If possible, samples will be collected from these wells within the same workday and no later than 24 hours after the start of purging.

Measure the well water level using the water level meter every 5 to 10 minutes. Record the well water level on the Low-Flow Purge Data Form (Attachment C).

Record on the Low-Flow Purge Data Form every 5 to 10 minutes the water quality parameters (pH, specific conductance, temperature, turbidity, oxidation-reduction potential, dissolved oxygen and salinity or as specified by the approved site specific work plan) measured by the water quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled/deionized water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form.

Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections.

After stabilization is achieved, sampling can begin when a minimum of two saturated screen volumes have been removed and three consecutive readings, taken at 5 to 10 minute intervals, are within the following limits:

- pH  $\pm 0.2$  standard units
- Specific conductance  $\pm 10\%$
- Temperature  $\pm 10\%$
- Turbidity less than 10 NTUs
- Dissolved oxygen  $\pm 10\%$

If the above conditions have still not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data Form onto the Groundwater Sample Log Form.

VOC samples are preferably collected first, directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the water column in the pump tubing collapses (water does not completely fill the tubing) before exiting the tubing, use one of the following procedures to collect VOC samples: (1) Collect the non-VOCs samples first, then increase the flow rate incrementally until the water column completely fills the tubing, collect the sample and record the new flow rate; (2) reduce the diameter of the existing tubing until the water column fills the tubing either by adding a connector (Teflon or stainless steel), or clamp which should reduce the flow rate by constricting the end of the tubing; (3) insert a narrow diameter Teflon tube into the pump's tubing so that the end of the tubing is in the water column and the other end of the tubing protrudes beyond the pump's tubing, collect sample from the narrow diameter tubing.

Prepare samples for shipping as per SOP SA-6.1.

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**ATTACHMENT A**  
**PURGING EQUIPMENT SELECTION**

Diameter Casing		Bailer	Peristaltic Pump	Vacuum Pump	Air-lift	Diaphragm "Trash" Pump	Submersible Diaphragm Pump	Submersible Electric Pump	Submersible Electric Pump w/Packer
1.25-Inch	Water level <25 feet	X	X	X	X	X			
	Water Level >25 feet	X			X				
2-Inch	Water level <25 feet	X	X	X	X	X	X		
	Water Level >25 feet	X			X		X		
4-Inch	Water level <25 feet	X	X	X	X	X	X	X	X
	Water Level >25 feet	X			X		X	X	X
6-Inch	Water level <25 feet				X	X		X	X
	Water Level >25 feet				X			X	X
8-Inch	Water level <25 feet				X	X		X	X
	Water Level >25 feet				X			X	X



**ATTACHMENT A**  
**PURGING EQUIPMENT SELECTION**  
**PAGE 2**

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/Length (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
BarCad Systems, Inc.	BarCad Sampler	Dedicated; gas drive (positive displacement)	1.5/16	PE, brass, nylon, aluminum oxide	0-150 with std. tubing	1 liter for each 10-15 feet of submergence	\$220-350	Requires compressed gas; custom sizes and materials available; acts as piezometer.
Cole-Parmer Inst. Co.	Master Flex 7570 Portable Sampling Pump	Portable; peristaltic (suction)	<1.0/NA	(not submersible) Tygon®, silicone Viton®	0-30	670 mL/min with 7015-20 pump head	\$500-600	AC/DC; variable speed control available; other models may have different flow rates.
ECO Pump Corp.	SAMPLifier	Portable; venturi	<1.5 or <2.0/NA	PP, PE, PVC, SS, Teflon®, Tefzel®	0-100	0-500 mL/min depending on lift	\$400-700	AC, DC, or gasoline-driven motors available; must be primed.
Geltek Corp.	Bailer 219-4	Portable; grab (positive displacement)	1.66/38	Teflon®	No limit	1,075 mL	\$120-135	Other sizes available.
GeoEngineering, Inc.	GEO-MONITOR	Dedicated; gas drive (positive displacement)	1.5/16	PE, PP, PVC, Viton®	Probably 0-150	Approximately 1 liter for each 10 feet of submergence	\$185	Acts as piezometer; requires compressed gas.
Industrial and Environmental Analysts, Inc. (IEA)	Aquarius	Portable; bladder (positive displacement)	1.75/43	SS, Teflon®, Viton®	0-250	0-2,800 mL/min	\$1,500-3,000	Requires compressed gas; other models available; AC, DC, manual operation possible.
IEA	Syringe Sampler	Portable; grab (positive displacement)	1.75/43	SS, Teflon®	No limit	850 mL sample volume	\$1,100	Requires vacuum and/or pressure from hand pump.
Instrument Specialties Co. (ISCO)	Model 2600 Well Sampler	Portable; bladder (positive displacement)	1.75/50	PC, silicone, Teflon®, PP, PE, Dextrin®, acetal	0-150	0-7,500 mL/min	\$990	Requires compressed gas (40 psi minimum).
Keck Geophysical Instruments, Inc.	SP-81 Submersible Sampling Pump	Portable; helical rotor (positive displacement)	1.76/25	SS, Teflon®, PP, EPDM, Viton®	0-160	0-4,500 mL/min	\$3,500	DC operated.
Leonard Mold and Die Works, Inc.	GeoFilter. Small Diameter Well Pump (#0500)	Portable; bladder (positive displacement)	1.75/38	SS, Teflon®, PC, Neoprene®	0-400	0-3,600 mL/min	\$1,400-1,500	Requires compressed gas (55 psi minimum); pneumatic or AC/DC control module.
Oil Recovery Systems, Inc.	Surface Sampler	Portable; grab (positive displacement)	1.75/12	acrylic, Dextrin®	No limit	Approximately 250 mL	\$125-160	Other materials and models available; for measuring thickness of "floating" contaminants.
Q.E.D. Environmental Systems, Inc.	Well Wizard® Monitoring System (P-100)	Dedicated; bladder (positive displacement)	1.66/38	PVC	0-230	0-2,000 mL/min	\$300-400	Requires compressed gas; piezometric level indicator; other materials available.

**ATTACHMENT A**  
**PURGING EQUIPMENT SELECTION**  
**PAGE 3**

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/L ength (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
Randolph Austin Co.	Model 500 Vari-Flow Pump	Portable; peristaltic (suction)	<0.5/NA	(Not submersible) Rubber, Tygon®, or Neoprene®	0-30	See comments	\$1,200-1,300	Flow rate dependent on motor and tubing selected; AC operated; other models available.
Robert Bennett Co.	Model 180	Portable; piston (positive displacement)	1.8/22	SS, Teflon®, Delrin® PP, Viton®, acrylic, PE	0-500	0-1,800 mL/min	\$2,600-2,700	Requires compressed gas; water level indicator and flow meter; custom models available.
Slope Indicator Co. (SINCO)	Model 514124 Pneumatic Water Sampler	Portable; gas drive (positive displacement)	1.9/18	PVC, nylon	0-1,100	250 mL/flushing cycle	\$250-350	Requires compressed gas; SS available; piezometer model available; dedicated model available.
Solinst Canada Ltd.	5W Water Sampler	Portable; grab (positive displacement)	1.9/27	PVC, brass, nylon, Neoprene®	0-330	500 mL	\$1,300-1,800	Requires compressed gas; custom models available.
TIMCO Mfg. Co., Inc.	Std. Bailer	Portable; grab (positive displacement)	1.66/Custo m	PVC, PP	No limit	250 mL/ft of bailer	\$20-60	Other sizes, materials, models available; optional bottom-emptying device available; no solvents used.
TIMCO	Air or Gas Lift Sampler	Portable; gas drive (positive displacement)	1.66/30	PVC, Tygon®, Teflon®	0-150	350 mL/flushing cycle	\$100-200	Requires compressed gas; other sizes, materials, models available; no solvents used.
Tole Devices Co.	Sampling Pump	Portable; bladder (positive displacement)	1.38/48	SS, silicone, Delrin®, Tygon®	0-125	0-4,000 mL/min	\$800-1,000	Compressed gas required; DC control module; custom built.

Construction Material Abbreviations:

PE Polyethylene  
PP Polypropylene  
PVC Polyvinyl chloride  
SS Stainless steel  
PC Polycarbonate  
EPDM Ethylene-propylene diene (synthetic rubber)

Other Abbreviations:

NA Not applicable  
AC Alternating current  
DC Direct current

NOTE: Other manufacturers market pumping devices which could be used for groundwater sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

Source: Barcelona et al., 1983.



# GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING

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ATTACHMENT C  
LOW FLOW PURGE DATA SHEET



WELL ID.:  
DATE:

[illegible]

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TETRA TECH NUS, INC.

# STANDARD OPERATING PROCEDURES

Number

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Effective Date

03/00

Revision

1

Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Subject

NON-RADIOLOGICAL SAMPLE HANDLING

Approved

D. Senovich

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## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide information on sample preservation, packaging, and shipping procedures to be used in handling environmental samples submitted for chemical constituent, biological, or geotechnical analysis. Sample chain-of-custody procedures and other aspects of field documentation are addressed in SOP SA-6.3. Sample identification is addressed in SOP CT-04.

## 2.0 SCOPE

This procedure:

- Describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped off site for chemical analysis.
- Provides instruction for sample packaging and shipping in accordance with current U.S. Department of Transportation (DOT) and International Air Transportation Association (IATA) regulations. IATA regulates transportation of hazardous materials by air (which is the mode of transportation used for shipping nearly all samples derived during TtNUS projects).

## 3.0 GLOSSARY

Hazardous Material - A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Under 49 CFR, the term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials, as well as materials designated as hazardous under the provisions of §172.101 and §172.102 and materials that meet the defining criteria for hazard classes and divisions in Part 173. With slight modifications, IATA has adopted DOT "hazardous materials" as IATA "Dangerous Goods."

Hazardous Waste - Any substance listed in 40 CFR, Subpart D (y261.30 et seq.), or otherwise characterized as ignitable, corrosive, reactive, or toxic (as defined by Toxicity Characteristic Leaching Procedure, TCLP, analysis) as specified under 40 CFR, Subpart C (y261.20 et seq.), that would be subject to manifest requirements specified in 40 CFR 262. Such substances are defined and regulated by EPA.

Marking - A descriptive name, identification number, instructions, cautions, weight, specification or UN marks, or combination thereof required on outer packaging of hazardous materials.

n.o.i - Not otherwise indicated (may be used interchangeably with n.o.s.).

n.o.s. - Not otherwise specified.

ORM - Other regulated material (see DOT 49 CFR 173.144).

Packaging - A receptacle and any other components or materials necessary for compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank-car tanks to perform a containment function in conformance with the minimum packaging requirements of 49 CFR 173.24(a) & (b).

Placard - Color-coded, pictorial sign which depicts the hazard class symbol and name and which is placed on the side of a vehicle transporting certain hazardous materials.

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#### Common Preservatives:

- Hydrochloric Acid - HCl
- Sulfuric Acid - H<sub>2</sub>SO<sub>4</sub>
- Nitric Acid - HNO<sub>3</sub>
- Sodium Hydroxide - NaOH

#### Other Preservatives

- Zinc Acetate
- Sodium Thiosulfate - Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing 1 gram-atom of replaceable hydrogen or its equivalent.

Reportable Quantity (RQ) - For the purposes of this SOP, means the quantity specified in column 3 of the Appendix to DOT 49 CFR §172.101 for any material identified in column 1 of the appendix. A spill greater than the amount specified must be reported to the National Response Center.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the location and time of collection.

## 4.0 RESPONSIBILITIES

Field Operations Leader - Directly responsible for the bottling, preservation, labeling, packaging, shipping, and custody of samples up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record (per SOP SA-6.3), implementing the packaging and shipping requirements, and maintaining custody of samples until they are relinquished to another custodian or to the shipper.

## 5.0 PROCEDURES

Sample identification, labeling, documentation, and chain-of-custody are addressed by SOP SA-6.3.

### 5.1 Sample Containers

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, whereas many organic chemicals may dissolve various types of plastic containers. Attachments A and B show proper containers (as well as other information) per 40 CFR 136. In general, the sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample warms during transport. However, for collection of volatile organic compounds, head space shall be omitted. The analytical laboratory will generally provide certified-clean containers for samples to be analyzed for chemical constituents. Shelby tubes or other sample containers are generally provided by the driller for samples requiring geotechnical analysis. Sufficient lead time shall be allowed for a delivery of sample container orders. Therefore, it is critical to use the correct container to maintain the integrity of the sample prior to analysis.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused



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containers which appear contaminated upon receipt, or which are found to have loose caps or a missing Teflon liner (if required for the container), shall be discarded.

## **5.2 Sample Preservation**

Many water and soil samples are unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Although complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that inevitably take place after the sample is collected. Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/ freezing (certain biological samples only).

### **5.2.1 Overview**

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or be added in the field (in a clean environment). Only high purity reagents shall be used for preservation. In general, aqueous samples of low-concentration organics (or soil samples of low- or medium-concentration organics) are cooled to 4°C. Medium-concentration aqueous samples, high-hazard organic samples, and some gas samples are typically not preserved. Low-concentration aqueous samples for metals are acidified with HNO<sub>3</sub>, whereas medium-concentration and high-hazard aqueous metal samples are not preserved. Low- or medium-concentration soil samples for metals are cooled to 4°C, whereas high-hazard samples are not cooled.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

### **5.2.2 Preparation and Addition of Reagents**

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade or purer and shall be diluted to the required concentration with deionized water before field sampling commences. To avoid uncontrolled reactions, be sure to Add Acid to water (not vice versa). A dilutions guide is provided below.

<b>Acid/Base</b>	<b>Dilution</b>	<b>Concentration</b>	<b>Estimated Amount Required for Preservation</b>
Hydrochloric Acid (HCl)	1 part concentrated HCl: 1 part double-distilled, deionized water	6N	5-10 mL
Sulfuric Acid (H <sub>2</sub> SO <sub>4</sub> )	1 part concentrated H <sub>2</sub> SO <sub>4</sub> : 1 part double-distilled, deionized water	18N	2 - 5 mL
Nitric Acid (HNO <sub>3</sub> )	Undiluted concentrated HNO <sub>3</sub>	16N	2 - 5 mL
Sodium Hydroxide (NaOH)	400 grams solid NaOH dissolved in 870 mL double-distilled, deionized water; yields 1 liter of solution	10N	2 mL

The amounts required for preservation shown in the above table assumes proper preparation of the preservative and addition of the preservative to one liter of aqueous sample. This assumes that the sample is initially at pH 7, is poorly buffered, and does not contain particulate matter; as these conditions vary, more preservative may be required. Consequently, the final sample pH must be checked using narrow-range pH paper, as described in the generalized procedure detailed below:

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- Pour off 5-10 mL of sample into a dedicated, clean container. Use some of this sample to check the initial sample pH using wide range (0-14) pH paper. Never dip the pH paper into the sample; always apply a drop of sample to the pH paper using a clean stirring rod or pipette.
- Add about one-half of the estimated preservative required to the original sample bottle. Cap and invert gently several times to mix. Check pH (as described above) using medium range pH paper (pH 0-6 or pH 7.5-14, as applicable).
- Cap sample bottle and seal securely.

Additional considerations are discussed below:

- To test if ascorbic acid must be used to remove oxidizing agents present in the sample before it can be properly preserved, place a drop of sample on KI-starch paper. A blue color indicates the need for ascorbic acid addition.

If required, add a few crystals of ascorbic acid to the sample and retest with the KI-starch paper. Repeat until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 grams of ascorbic acid per each liter of sample volume.

Continue with proper base preservation of the sample as described above.

- Samples for sulfide analysis must be treated by the addition of 4 drops (0.2 mL) of 2N zinc acetate solution per 100 ml of sample.

The 2N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 mL of double-distilled, deionized water to make 1 liter of solution.

The sample pH is then raised to 9 using the NaOH preservative.

- Sodium thiosulfate must be added to remove residual chlorine from a sample. To test the sample for residual chlorine use a field test kit specially made for this purpose.

If residual chlorine is present, add 0.08 grams of sodium thiosulfate per liter of sample to remove the residual chlorine.

Continue with proper acidification of the sample as described above.

For biological samples, 10% buffered formalin or isopropanol may also be required for preservation. Questions regarding preservation requirements should be resolved through communication with the laboratory before sampling begins.

### 5.3 Field Filtration

At times, field-filtration may be required to provide for the analysis of dissolved chemical constituents. Field-filtration must be performed prior to the preservation of samples as described above. General procedures for field filtration are described below:

- The sample shall be filtered through a non-metallic, 0.45-micron membrane filter, immediately after collection. The filtration system shall consist of dedicated filter canister, dedicated tubing, and a peristaltic pump with pressure or vacuum pumping squeeze action (since the sample is filtered by mechanical peristalsis, the sample travels only through the tubing).

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- To perform filtration, thread the tubing through the peristaltic pump head. Attach the filter canister to the discharge end of the silicon tubing (note flow direction arrow); attach the aqueous sample container to the intake end of the silicon tubing. Turn the peristaltic pump on and perform filtration. Run approximately 100 ml of sample through the filter prior to sample collection.
- Continue by preserving the filtrate (contained in the filter canister), as applicable and generally described above.

#### 5.4 **Sample Packaging and Shipping**

Samples collected for shipment from a site shall be classified as either environmental or hazardous material samples. Samples from drums containing materials other than Investigative Derived Waste (IDW) and samples obtained from waste piles or bulk storage tanks are generally shipped as hazardous materials. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples (if there is any doubt, a sample shall be considered hazardous and shipped accordingly.)
- Protect the health and safety of transport and laboratory personnel receiving the samples (special precautions are used by the shipper and at laboratories when hazardous materials are received.)

Detailed procedures for packaging environmental and hazardous material samples are outlined in the remainder of this section.

##### 5.4.1 **Environmental Samples**

Environmental samples are packaged as follows:

- Place properly identified sample container, with lid securely fastened, in a plastic bag (e.g. Ziploc baggie), and seal the bag.
- Place sample in a cooler constructed of sturdy material which has been lined with a large, plastic (e.g. "garbage" bag). Drain plugs on coolers must be taped shut.
- Pack with enough noncombustible, absorbent, cushioning materials such as vermiculite (shoulders of bottles must be iced if required) to minimize the possibility of the container breaking.
- If cooling is required (see Attachments A and B), double-bag ice in Ziploc baggies and place around sample container shoulders, and on top of absorbent packing material (minimum of 8 pounds of ice for a medium-size cooler).
- Seal (i.e., tape or tie top in knot) large liner bag.
- The original (top, signed copy) and extra carbonless copies of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the first cooler. The COC form should then state how many coolers are included with that shipment.
- Close and seal outside of cooler as described in SOP SA-6.3. Signed custody seals must be used.

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Coolers must be marked as containing "Environmental Samples." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling is required; there are no DOT restrictions on mode of transportation.

#### **5.4.2 Hazardous Material Samples**

Samples not determined to be environmental samples, or samples known or expected to contain hazardous materials, must be considered hazardous material samples and transported according to the requirements listed below.

NOTE: Packaging and shipping of hazardous materials can only be performed by personnel who have participated in the TtNUS training course "Shipping Hazardous Materials" (or equivalent training approved by Health Sciences).

##### **5.4.2.1 Known Substances**

If the substance in the sample is known or can be identified, package, mark, label, and ship according to the specific instructions for that material (if it is listed) in the DOT Hazardous Materials Table (49 CFR 172.101) or the IATA List of Dangerous Goods Table (IATA Dangerous Goods Regulations). DOT Guide for shippers can be found in Attachment D of this document.

To determine the proper shipping name, use the following steps to help locate the shipping name on the Hazardous Materials Table, DOT 49 CFR 172.101.

1. Look first for the chemical or technical name of the material, for example, ethyl alcohol. Note that many chemicals have more than one technical name, for example, perchloroethylene (not listed in 172.101) is listed as tetrachloroethylene (listed 172.101). It may be useful to consult Health Sciences or a chemist for all possible technical names a material can have. If your material is not listed by its technical name, then . . .
2. Look for the chemical family name. For example, pentyl alcohol is not listed but the chemical family name is: alcohol, n.o.s. (not otherwise specified). If the chemical family name is not listed, then . . .
3. Look for a generic name based on end use. For example, Paint, n.o.s. If a generic name based on end use is not listed, then . . .
4. Look for a generic family name based on end use, for example, drugs, n.o.s. or cosmetics, n.o.s. Finally, if your material is not listed by a generic family name but you suspect or know the material is hazardous because it meets the definition of one or more hazardous classes, then . . .
5. You will have to use the general hazard class for a proper shipping name. For example, Flammable Liquid, n.o.s. or Oxidizer, n.o.s.

If you have any doubt regarding the proper shipping name, contact Health Sciences in Pittsburgh, Pennsylvania for assistance.

##### **5.4.2.2 Unknown Substances**

For samples of hazardous substances that are not listed on the Hazardous Materials Table, or are of unknown content, the shipper is required to:

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1. Determine that the substance is not forbidden for shipment. Items forbidden include explosives (solid and liquid), substances liable to produce a dangerous evolution of heat or gas, and listed "unusual" compounds (which TtNUS fortunately does not typically handle). If the substance is in any way atypical of routine shipments, contact Health Sciences for further information on determining if the substance is forbidden.
2. Classify the substance by assessing whether it is anticipated to exhibit any unusual physical properties as defined by DOT (flammability, explosivity, etc.). If the substance has more than one hazard, follow the hazardous materials classification scheme identified in Attachment C of this SOP.
3. Use the generic or "n.o.s." proper shipping name that most accurately describes the article or substance. There are two types of general proper shipping names:
  - Generic, e.g., Alcohols, n.o.s. \*
  - Hazard description, e.g., Flammable liquid, n.o.s.\*

Generic or n.o.s. proper shipping names marked with an "\*" require the addition of the technical name in parenthesis ( ) immediately following the proper shipping name. For example, most of our instrument calibration gases are not listed by name and must be declared under the most accurately descriptive name, which is "Compressed Gas, n.o.s. (Mixture Nitrogen and Oxygen)".

The correct shipping classification for an unknown sample is therefore selected through a process of elimination as described above (and detailed in 49 CFR 172.101(c)(11)). By using the provisions in this paragraph, the proper shipping name and description will be determined. A step-by-step guide is provided by the DOT and can be found in Attachment D of this SOP. Again, if you have any doubt regarding the proper shipping name, contact Health Sciences for assistance.

#### **5.4.3 Packaging and Shipping of Samples Classified as Flammable Liquid (or Solid)**

##### **5.4.3.1 Packaging**

Applying the word "flammable" to a sample does not necessarily mean that it is in fact flammable. The word prescribes the class of packaging according to DOT regulations and classification schemes. The DOT defines flammable liquids as substances with a flash point less than 140°F (60°C). For shipping purposes, liquids with a flash point exceeding 95°F (35°C) need not be considered as flammable liquids if they are miscible solutions and have a water content of more than 90% by weight. For solutions classified as flammable liquids:

1. Containerize sample as required (see Attachments A and B). To prevent leakage, fill container no more than 90 percent full. Seal lid with teflon tape or wire.
2. Complete sample label and attach securely to sample container.
3. Seal container and place in 2-mil-thick (or thicker) polyethylene bag (e.g., Ziploc baggie), one sample per bag. Position sample identification label so that it can be read through bag. Seal bag.
4. For soil jars, place sealed bag inside metal can (available from laboratory or laboratory supplier) and cushion it with enough noncombustible, absorbent material (for example, vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly and permanently. Mark can as indicated in Paragraph 1 of Section 5.3.4.2, below. Single 1-gallon bottles do not need to be placed in metal cans.

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5. Place one or more metal cans (or a single 1-gallon bottle) into a strong outside container, such as a metal picnic cooler or a DOT-approved fiberboard box. Surround cans (or bottle) with noncombustible, absorbent cushioning materials for stability during transport. The absorbent material should be able to absorb the entire contents of the container. Mark container as indicated in Paragraph 2 below.

#### 5.4.3.2 Marking/Labeling

1. Use abbreviations only where specified. Place the following information, either hand-printed or in label form, on the metal can (or 1-gallon bottle):
  - Laboratory name and address.
  - Proper shipping name from the hazardous materials table (DOT Regulation CFR 49 172.101). Example: "Flammable Liquid, n.o.s. (with the technical name in parentheses).
2. Determine packing group. The packing group must be included on the shipping papers in the description section. Packaging groups are classified as follows:
 

Group I.	Most Hazardous
Group II.	Medium Hazard
Group III.	Least Hazardous

The packing group will be listed in the hazardous materials table, column 5.
3. Place the following information on outside shipping container per the instructions provided in the "Shipping Hazardous Materials" course:
  - Proper shipping name
  - UN or NA number
  - Proper label(s)
  - Addressee and sender

For flammable liquids, the following are the proper labels to be placed on the outside shipping container:

- DOT "Flammable liquid" label
- Package orientation label (arrows pointing upward) on at least two opposite sides of the package
- "Cargo Aircraft Only" label if shipping more than 30L of flammable liquids in the package.

#### 5.4.3.3 Shipping Papers

Principally because of limitations in sample holding times, TtNUS almost exclusively uses air transportation to ship hazardous materials and other environmental samples. The "Dangerous Goods Airbill" is the shipping paper used to document the information associated with the shipment. As identified previously, only personnel who have participated in "Shipping Hazardous Materials" training (or equivalent course) are authorized to prepare hazardous materials for shipment - including preparation of associated shipping papers. Included in this training are instructions on what specific information is to be provided on the Airbill for hazardous materials typically shipped by TtNUS. Refer to the training course Student Manual or contact Health Sciences for this information.

The properly executed Chain-of-Custody Report must be included in the container. Use custody seals.

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Using the Airbill of our common carrier (i.e., Federal Express) as an example, the following instructions apply to the information to be provided under "Transport Details", "Nature and Quantity of Dangerous Goods", and other associated fields.

a) Transport Details

- Select "Passenger and Cargo" or "Cargo Aircraft Only" (This is based on the type and quantity of dangerous goods you are shipping). X-out the non-applicable selection.
- Airport of Departure - Enter the full name of the airport or city of departure.
- Airport of Destination - Enter the full name of the airport or city of destination.

b) Shipment Type – Delete the option that does not apply (Non-Radioactive/Radioactive)

c) Nature and Quantity of Dangerous Goods

1. Dangerous Goods Identification

- Proper Shipping Name - List the proper shipping name (this is the name as it appears on the List of Dangerous Goods Table and NOT the product or trade name), and if applicable, the technical name in parenthesis.
- Class or Division - List the class or division number and, if applicable, compatibility group.
- UN or ID No - List the UN or I.D. number, preceded with "UN" or "I.D." This selection may change when shipping in accordance with 49 CFR regulations that permit the shipment under NA (North American Continental Shipments) designations for certain substances.
- Packing Group – List the appropriate packing group, if applicable. This is the level of anticipated hazard of the shipment. It does not apply for all shipments. When no information is available, leave the space blank.
- Subsidiary Risk – List the class or division number of the subsidiary risk, if applicable. The subsidiary risk is any additional hazard beyond the most significant (or primary) hazard. This information is obtained from the List of Dangerous Goods Table.

2. Quantity and Type of Packaging – List the number of packages, the type of package, and the net quantity in each package. The type of packaging you are shipping the hazardous material in is presented first, followed by the amount (Kg, L, etc.). For example, "1 fiberboard box X 2 Kg". When no outer packaging is identified, the packaging selected must provide limited protection of the inner packaging by securing and cushioning during shipment. NOTE: Always use the package that the hazardous material was shipped to the site in. If it is not available, contact the Health Sciences Department in Pittsburgh for further instruction.

3. Packing Instructions – Enter the Packing Instruction number. These instructions are provided in Section 5 of the IATA Dangerous Goods Regulations. They provide the exact type of packaging required by the industry for various hazard classes. When no addition packaging considerations are given, the shipper may use their best judgment for the shipment of an identified substance and/or article.

4. Authorization – List the words " Limited Quantity," if applicable; list any special provision(s) or approval(s) if applicable. This section provides for exceptions to this transportation regulation and the conditions for those exceptions.



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- d) Additional handling Information - Enter any required special handling information.
- e) Prepared for Air Transport according to: Check the ICAO/IATA box.
- f) Emergency Telephone Number - Enter the 24-hour emergency contact number. This number is required of all US Origin or Destination Shipments. List the number for InfoTRAC (1-800-535-5053). InfoTRAC is a company retained by TtNUS to provide 24-Hour Emergency Hotline service for dangerous goods shipment. This company has MSDSs for the substances routinely shipped by TtNUS. They provide information to FedEx or any other emergency responders, should situations arise with one of our shipments. In addition, they have telephone numbers of certain Tetra Tech NUS Health Science Department personnel in the Pittsburgh Office in the event of an emergency.
- g) Name/Title of the Signatory - Enter name and job title (Field Operations Leader, Geologist, Health & Safety Specialist, etc.)
- h) Place and date - Enter the city and date of shipment
- i) Signature - Sign the form (must be a complete signature). All alterations must be signed with the same signature used to sign the declaration.

#### 5.4.3.4 Transportation

1. The majority of unknown hazardous substance samples will be classified as flammable liquids. The samples will be transported by rented or common carrier truck, railroad, or express overnight package services. Do not transport samples on any passenger-carrying air transport system, even if the system has cargo-only aircraft. DOT regulations permit regular airline cargo-only aircraft, but difficulties with most suggest avoiding them. Instead, ship by airline carriers that carry only cargo. If unsure of what mode of transportation to use, consult Health Sciences.<sup>1</sup>
2. For transport by government-owned vehicle, including aircraft, DOT regulations do not apply. However, procedures described above, with the exception of execution of the bill of lading with certification, shall still be followed.
3. Use the hazardous materials shipping check list (Attachment E) as a guidance to ensure that all sample-handling requirements are satisfied.
4. In some cases, various materials may react if they break during shipment. To determine if you are shipping such materials, refer to the DOT compatibility chart in Attachment F.

#### 5.5 Shipment of Lithium Batteries

Monitoring well data are analyzed using either the Hermit SE 1000 or the Hermit SE 2000 environmental data logger. These instruments are typically powered by lithium batteries in sufficient quantity to make the unit subject to hazardous material shipping requirements. The DOT determined that lithium batteries are to be shipped using the following information:

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<sup>1</sup> Note: If you are unsure as how to ship the sample (hazardous or environmental sample), contact Health Sciences so that a decision can be made as to the proper shipping practices. The DOT and IATA penalties for improper shipment of a hazardous material are stringent and may include a prison term for intentional violations.

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- Product Designation
  - Hermit SE 1000
  - Hermit SE 2000
- Proper Shipping Name
  - Lithium batteries, contained in equipment, UN3091
- UN No - UN-3091
- Classification or Division
  - Class 9

Shipment of equipment containing lithium batteries must be accompanied by shipping papers completed as indicated in Attachment G. The instrument will be shipped by Federal Express as a Hazardous Material. Place the instrument in the same container in which it was received. This container or case is a DOT-approved shipping container. For Federal Express procedures to ship hazardous materials, call 1-800-238-5355, extension 922-1666. In most cases, the return shipping papers and DOT labels will be shipped to you from the company warehouse or the vendor. An example of the types of labels used for shipment and the wording are shown in Attachment G. These labels will be attached to the outside container and include all the information noted under Section 5.4.3.2. Instead of the Flammable Liquid information, however, the following will be presented with the following wording:

- Lithium Batteries Contained in Equipment
  - UN-3091
- DOT Miscellaneous Hazardous Materials (Class 9) label
- "Cargo Aircraft Only" label

## 6.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater, 15th Edition. APHA, Washington, D.C.

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## ATTACHMENT A

### GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Sample Type and Concentration	Container <sup>(1)</sup>	Sample Size	Preservation <sup>(2)</sup>	Holding Time <sup>(2)</sup>
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#### WATER

Organics (GC&GC/MS)	VOC	Low	Borosilicate glass	2 x 40 mL	Cool to 4°C HCl to ≤ 2	14 days <sup>(9)</sup>
	Extractables SVOCs and pesticide/PCBs)	(Low	Amber glass	2x2 L or 4x1 L	Cool to 4°C	7 days to extraction; 40 days after extraction
	Extractables SVOCs and pesticide/PCBs)	(Medium	Amber glass	2x2 L or 4x1 L	None	7 days to extraction; 40 days after extraction
Inorganics	Metals	Low	High-density polyethylene	1 L	HNO <sub>3</sub> to pH ≤2	6 months (Hg-28 days)
		Medium	Wide-mouth glass	16 oz.	None	6 months
	Cyanide	Low	High-density polyethylene	1 L	NaOH to pH>12	14 days
	Cyanide	Medium	Wide-mouth glass	16 oz.	None	14 days
Organic/ Inorganic	High Hazard		Wide-mouth glass	8 oz.	None	14 days

#### SOIL

Organics (GC&GC/MS)	VOC		Wide-mouth glass with teflon liner	2 x 4 oz.	Cool to 4°C	14 days
	Extractables SVOCs and pesticides/PCBs)	(Low	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
	Extractables SVOCs and pesticides/PCBs)	(Medium	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
Inorganics	Low/Medium		Wide-mouth glass	8 oz.	Cool to 4°C	6 months (Hg - 28 days) Cyanide (14 days)
Organic/Inorga nic	High Hazard		Wide-mouth glass	8 oz.	None	NA
Dioxin/Furan	All		Wide-mouth glass	4 oz.	None	7 days until extraction; 40 days after extraction
TCLP	All		Wide-mouth glass	8 oz.	None	7 days until preparation; analysis as per fraction

#### AIR

Volatile Organics	Low/Medium	Charcoal tube -- 7 cm long, 6 mm OD, 4 mm ID	100 L air	Cool to 4°C	5 days recommended
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- 1 All glass containers should have Teflon cap liners or septa.
- 2 See Attachment E. Preservation and maximum holding time allowances per 40 CFR 136.

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## ATTACHMENT B

### ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter Number/Name	Container <sup>(1)</sup>	Preservation <sup>(2)(3)</sup>	Maximum Holding Time <sup>(4)</sup>
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#### INORGANIC TESTS:

Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia - Nitrogen	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Biochemical Oxygen Demand (BOD)	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Chemical Oxygen Demand (COD)	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Chloride	P, G	None required	28 days
Chlorine, Total Residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P, G	Cool, 4°C; NaOH to pH 12; 0.6 g ascorbic acid <sup>(5)</sup>	14 days <sup>(6)</sup>
Fluoride	P	None required	28 days
Hardness	P, G	HNO <sub>3</sub> to pH 2; H <sub>2</sub> SO <sub>4</sub> to pH 2	6 months
Total Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Nitrate - Nitrogen	P, G	None required	48 hours
Nitrate-Nitrite - Nitrogen	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Nitrite - Nitrogen	P, G	Cool, 4°C	48 hours
Oil & Grease	G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Total Organic Carbon (TOC)	P, G	Cool, 4°C; HCl or H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Orthophosphate	P, G	Filter immediately; Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle & top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle & top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Phosphorus, Total	P, G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH 2	28 days
Residue, Total	P, G	Cool, 4°C	7 days
Residue, Filterable (TDS)	P, G	Cool, 4°C	7 days
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, Settleable	P, G	Cool, 4°C	48 hours
Residue, Volatile (Ash Content)	P, G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days

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**ATTACHMENT B  
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,  
AND HOLDING TIMES  
PAGE TWO**

Parameter Number/Name	Container <sup>(1)</sup>	Preservation <sup>(2)(3)</sup>	Maximum Holding Time <sup>(4)</sup>
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**INORGANIC TESTS (Cont'd):**

Sulfide	P, G	Cool, 4°C; add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours

**METALS:<sup>(7)</sup>**

Chromium VI (Hexachrome)	P, G	Cool, 4°C	24 hours
Mercury (Hg)	P, G	HNO <sub>3</sub> to pH 2	28 days
Metals, except Chromium VI and Mercury	P, G	HNO <sub>3</sub> to pH 2	6 months

**ORGANIC TESTS:<sup>(8)</sup>**

Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup>	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup> HCl to pH 2 <sup>(9)</sup>	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup> adjust pH to 4-5 <sup>(10)</sup>	14 days
Phenols <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup>	7 days until extraction; 40 days after extraction
Benzidines <sup>(11), (12)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup>	7 days until extraction <sup>(13)</sup>
Phthalate esters <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitrosamines <sup>(11), (14)</sup>	G, Teflon-lined cap	Cool, 4°C; store in dark; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup>	7 days until extraction; 40 days after extraction
PCBs <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitroaromatics & Isophorone <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup> ; store in dark	7 days until extraction; 40 days after extraction
Polynuclear Aromatic Hydrocarbons (PAHs) <sup>(11), (14)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup> ; store in dark	7 days until extraction; 40 days after extraction
Haloethers <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup>	7 days until extraction; 40 days after extraction
Dioxin/Furan (TCDD/TCDF) <sup>(11)</sup>	G, Teflon-lined cap	Cool, 4°C; 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> <sup>(5)</sup>	7 days until extraction; 40 days after extraction

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**ATTACHMENT B  
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,  
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PAGE THREE**

- (1) Polyethylene (P): generally 500 ml or Glass (G): generally 1L.
- (2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
- (3) When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).
- (4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer periods, and has received a variance from the Regional Administrator.
- (5) Should only be used in the presence of residual chlorine.
- (6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments are made to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.
- (7) Samples should be filtered immediately on site before adding preservative for dissolved metals.
- (8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
- (9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.
- (10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
- (11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).
- (12) If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.
- (13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
- (14) For the analysis of diphenylnitrosamine, add 0.008% Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> and adjust pH to 7-10 with NaOH within 24 hours of sampling.
- (15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>.

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### **ATTACHMENT C**

#### **DOT HAZARDOUS MATERIAL CLASSIFICATION (49 CFR 173.2a)**

1. Radioactive material (except a limited quantity)
2. Division 2.3, Poisonous Gases
3. Division 2.1, Flammable Gas
4. Division 2.2, Nonflammable gas
5. Division 6.1, Poisonous Liquids, Packing Group 1 (poison by inhalation only)
6. Division 4.2, Pyrophoric Material
7. Division 4.1, Self-Reactive Material
8. Class 3, Flammable Liquids\*
9. Class 8, Corrosive Material
10. Division 4.1, Flammable Solid\*
11. Division 4.2, Spontaneously Combustible Materials\*
12. Division 4.3, Dangerous When Wet Materials\*
13. Division 5.1, Oxidizers\*
14. Division 6.1, Poisonous Liquids or Solids (other than Packing Group 1)\*
15. Combustible liquid
16. Class 9, Miscellaneous Hazardous Materials

\* If a material has or meets the criteria for more than one hazard class, use the precedence of hazardous table on the following page for Classes 3 and 8 and Divisions 4.1, 4.2, 4.3, 5.1, and 6.1. The following table ranks those materials that meet the definition of Classes 3 and 8 and Divisions 4.1, 4.2, 4.3, 5.1, and 6.1.



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### ATTACHMENT C (Continued)

#### DOT HAZARDOUS MATERIAL CLASSIFICATION (49 CFR 173.2a)

Class	Packing Group	4.2	4.3	5.1 I <sup>(a)</sup>	5.1 II <sup>(a)</sup>	5.1 III <sup>(a)</sup>	6.1 I (Dermal)	6.1 I (Oral)	6.1 II	6.1 III	8 I (Liquid)	8 I (Solid)	8 II (Liquid)	8 II (Solid)	8 III (Liquid)	8 III (Solid)
3	I						3	3	3	3	3	(c)	3	(c)	3	(c)
3	II						3	3	3	3	8	(c)	3	(c)	3	(c)
3	III						6.1	6.1	6.1	3 <sup>(d)</sup>	8	(c)	8	(c)	3	(c)
4.1	II <sup>b</sup>	4.2	4.3	5.1	4.1	4.1	6.1	6.1	4.1	4.1	(c)	8	(c)	4.1	(c)	4.1
4.1	III <sup>b</sup>	4.2	4.3	5.1	4.1	4.1	6.1	6.1	6.1	4.1	(c)	8	(c)	8	(c)	4.1
4.2	II		4.3	5.1	4.2	4.2	6.1	6.1	4.2	4.2	(c)	8	(c)	4.2	(c)	4.2
4.2	III		4.3	5.1	4.2	4.2	6.1	6.1	6.1	4.2	(c)	8	(c)	8	(c)	4.2
4.3	I			5.1	4.3	4.3	6.1	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
4.3	II			5.1	4.3	4.3	6.1	4.3	4.3	4.3	8	8	8	4.3	4.3	4.3
4.3	III			5.1	4.3	4.3	6.1	6.1	6.1	4.3	8	8	8	8	4.3	4.3
5.1	I <sup>a</sup>						5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
5.1	II <sup>a</sup>						6.1	5.1	5.1	5.1	8	8	8	5.1	5.1	5.1
5.1	III <sup>a</sup>						6.1	6.1	6.1	5.1	8	8	8	8	5.1	5.1
6.1	I, Dermal										8	6.1	6.1	6.1	6.1	6.1
6.1	I, Oral										8	6.1	6.1	6.1	6.1	6.1
6.1	II, Inhalation										8	6.1	6.1	6.1	6.1	6.1
6.1	II, Dermal										8	6.1	8	6.1	6.1	6.1
6.1	II, Oral										8	8	8	6.1	6.1	6.1
6.1	III										8	8	8	8	8	8

- (a) There are at present no established criteria for determining Packing Groups for liquids in Division 5.1. At present, the degree of hazard is to be assessed by analogy with listed substances, allocating the substances to Packing Group I, Great; Group II, Medium; or Group III, Minor Danger.
- (b) Substances of Division 4.1 other than self-reactive substances.
- (c) Denotes an impossible combination.
- (d) For pesticides only, where a material has the hazards of Class 3, Packing Group III, and Division 6.1, Packing Group III, the primary hazard is Division 6.1, Packing Group III.

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## ATTACHMENT D

### GUIDE FOR HAZARDOUS MATERIALS SHIPPERS

**USE OF GUIDE** - This guide is presented as an aid to shippers of hazardous materials. It does not contain or refer to all of the DOT requirements for shipping hazardous materials. For specific details, refer to all of the DOT requirements for shipping hazardous materials, as provided in the Code of Federal Regulations (CFR), Title 49, Transportation, Parts 100-199.

The following is offered as a step-by-step procedure to aid in compliance with the applicable DOT regulations.

**STEP 1 - DETERMINE THE PROPER SHIPPING NAME.** The shipper must determine the proper shipping name of the materials as listed in the Hazardous Materials Table, 49 CFR 172.101, Column (2).

**STEP 2 - DETERMINE THE HAZARD CLASS OR CLASSES.**

- a. Refer to the Table, 49 CFR 172.101, Column (3), and locate the hazard class of the material.
- b. If more than one class is shown for the proper shipping name, determine the proper class by definition.
- c. If the materials have more than one hazard, classify the material based on the order of hazards in 49 CFR 173.2.

**STEP 3 - SELECT THE PROPER IDENTIFICATION NUMBERS.**

- a. Refer to the Table, 49 CFR 172.101, Column (3a), and select the Identification Number (ID) that corresponds to the proper shipping name and hazard class.
- b. Enter the ID number(s) on the shipping papers and display them, as required, on packagings, placards and/or orange panels.

**STEP 4 - DETERMINE THE MODE(S) OF TRANSPORT TO ULTIMATE DESTINATION.**

- a. As a shipper, you must assure yourself that the shipment complies with various modal requirements.
- b. The modal requirements may affect the following: (1) Packaging; (2) Quantity per Package; (3) Marking; (4) Labeling; (5) Shipping Papers; and (6) Certification.

**STEP 5 - SELECT THE PROPER LABEL(S) AND APPLY AS REQUIRED.**

- a. Refer to the Table, 49 CFR 172.101, Column (4) for required labels.
- b. For details on labeling refer to (1) Additional Labels, 49 CFR 172.402; (2) Placement of Labels, 49 CFR 172.406; (3) Packagings (Mixed or Consolidated), 49 CFR 172.404(a) and (h); (4) Packages Containing Samples, 49 CFR 172.402(h); (5) Radioactive Materials, 49 CFR 172.403; and (6) Authorized Label Modifications, 49 CFR 172.405.

**STEP 6 - DETERMINE AND SELECT THE PROPER PACKAGES.**

- a. Refer to the Table, 49 CFR 172.101, Column (5a) for exceptions and Column (5b) for specification packagings. Consider the following when selecting an authorized package: Quantity per Package; Cushioning Material, if required; Proper Closure and Reinforcement; Proper Pressure; Outage; etc., as required.
- b. If packaged by a prior shipper, make sure the packaging is correct and in proper condition for transportation.

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**ATTACHMENT D (Continued)**  
**GUIDE FOR HAZARDOUS MATERIALS SHIPPERS**

**STEP 7 - MARK THE PACKAGING (INCLUDING OVERPACKS).**

- a. Apply the required markings (49 CFR 172.300); Proper shipping name and ID number, when required (49 CFR 172.301); Name and address of Consignee or Consignor (49 CFR 172.306).
- b. For details and other required markings, see 49 CFR 172.300 through 172.338.

**STEP 8 - PREPARE THE SHIPPING PAPERS.**

- a. The basic requirements for preparing shipping papers include Proper Shipping Name; Hazard Class; ID Number; Total Quantity; Shipper's Certification; and Emergency Response Telephone Number.
- b. Make all entries on the shipping papers using the information required and in proper sequence (49 CFR 172.202).

**STEP 9 - CERTIFICATION.**

- a. Each shipper must certify by printing (manually or mechanically) on the shipping papers that the materials being offered for shipment are properly classified, described, packaged, marked and labeled, and in proper condition for transportation according to the applicable DOT Regulations (49 CFR 172.202).

**STEP 10 - LOADING, BLOCKING, AND BRACING.** When hazardous materials are loaded into the transport vehicle or freight container, each package must be loaded, blocked, and braced in accordance with the requirements for mode of transport.

- a. If the shipper loads the freight container or transport vehicle, the shipper is responsible for the proper loading, blocking, and bracing of the materials.
- b. If the carrier does the loading, the carrier is responsible.

**STEP 11 - DETERMINE THE PROPER PLACARD(S).** Each person who offers hazardous materials for transportation must determine that the placarding requirements have been met.

- a. For Highway, unless the vehicle is already correctly placarded, the shipper must provide the required placard(s) and required ID number(s) (49 CFR 172.506).
- b. For Rail, if loaded by the shipper, the shipper must placard the rail car if placards are required (49 CFR 172.508).
- c. For Air and Water shipments, the shipper has the responsibility to apply the proper placards.

**STEP 12 - HAZARDOUS WASTE/HAZARDOUS SUBSTANCE.**

- a. If the material is classed as a hazardous waste or hazardous substance, most of the above steps will be applicable.
- b. Pertinent Environmental Protection Agency regulations are found in the Code of Federal Regulations, Title 40, Part 262.

**As a final check and before offering the shipment for transportation, visually inspect the shipment. The shipper should ensure that emergency response information is on the vehicle for transportation of hazardous materials.**

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## **ATTACHMENT E**

### **HAZARDOUS MATERIALS SHIPPING CHECK LIST**

#### **PACKAGING**

1. Check DOT 173.24 for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample and for chain-of-custody record.

#### **SHIPPING PAPERS**

1. Check that entries contain only approved DOT abbreviations.
2. Check that entries are in English.
3. Check that hazardous material entries are specially marked to differentiate them from any nonhazardous materials being sent using same shipping paper.
4. Be careful that all hazardous classes are shown for multiclass materials.
5. Check total amounts by weight, quantity, or other measures used.
6. Check that any limited-quantity exemptions are so designated on the shipping paper.
7. Check that certification is signed by shipper.
8. Make certain driver signs for shipment.

#### **RCRA MANIFEST**

1. Check that approved state/federal manifests are prepared.
2. Check that transporter has the following: valid EPA identification number, valid driver's license, valid vehicle registration, insurance protection, and proper DOT labels for materials being shipped.
3. Check that destination address is correct.
4. Check that driver knows where shipment is going.
5. Check that the driver is aware of emergency procedures for spills and accidents.
6. Make certain driver signs for shipment.
7. Make certain one copy of executed manifest and shipping document is retained by shipper.

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**ATTACHMENT F  
DOT SEGREGATION AND SEPARATION CHART**

Class or Division	Notes	1.1-1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3 gas Zone A*	2.3 gas Zone B*	3	4.1	4.2	4.3	5.1	5.2	6.1 liquids PG-I Zone A*	7	8 liquids only
Explosives... 1.1 and 1.2	A	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Explosives..... 1.3		*	*	*	*	*	X		X	X	X	X	X	X	X	X	X	X	X
Explosives..... 1.4		*	*	*	*	*	O		O	O	O		O	O	X	X	O		O
Very insensitive explosives..... 1.5	A	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Extremely insensitive explosives..... 1.6		*	*	*	*	*													
Flammable gases .... 2.1		X	X	O	X				X	O							O	O	
Non-toxic, non-flammable gases .... 2.2		X			X														
Poisonous gas - Zone A** ..... 2.3		X	X	O	X		X				X	X	X	X	X	X			X
Poisonous gas - Zone B** ..... 2.3		X	X	O	X		O				O	O	O	O	O	O			O
Flammable liquids..... 3		X	X	O	X				X	O					O		X		
Flammable solids..... 4.1		X			X				X	O							X		O
Spontaneously combustible materials ..... 4.2		X	X	O	X				X	O							X		X
Dangerous-when-wet materials ..... 4.3		X	X		X				X	O							X		O
Oxidizers ..... 5.1	A	X	X		X				X	O	O						X		O
Organic peroxides.... 5.2		X	X		X				X	O							X		O
Poisonous liquids PG I - Zone A** ..... 6.1		X	X	O	X		O				X	X	X	X	X	X			X
Radioactive materials . 7		X			X		O												
Corrosive liquids ..... 8		X	X	O	X				X	O		O	X	O	O	O	X		

No entry means that the materials are compatible (have no restrictions).

X These materials may not be loaded, transported, or stored together in the same vehicle or facility.

O The materials may not be loaded, transported, or stored together in the same vehicle or facility unless they are separated for 4 feet on all sides.

\* Check the explosives compatibility chart in 49 CFR 179.848(f).

A Ammonium nitrate fertilizers may be stored with Division 1.1 materials.

\*\* Denotes inhalation hazardous for poisons; consult field team leader or project manager if you encounter a material in this class 1 before shipment.

Subject  
NON-RADIOLOGICAL SAMPLE  
HANDLING

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ATTACHMENT G  
LITHIUM BATTERY SHIPPING PAPERS

3224637861

Two completed and signed copies of this Declaration must be handed to the operator.

**WARNING**

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

<b>TRANSPORT DETAILS</b>	
This shipment is within the limitations prescribed for: (delete non applicable) <del>PERMIT REQUIRED</del> <del>OTHER</del> <del>XXXXXX</del>	Airport of Departure
<del>PERMIT REQUIRED</del> <del>OTHER</del> <del>XXXXXX</del>	CARGO AIRCRAFT ONLY
Airport of Destination: 19CYS	

Shipment type: (delete non-applicable)

NON-RADIOACTIVE ~~RADIOACTIVE~~

**NATURE AND QUANTITY OF DANGEROUS GOODS**

Dangerous Goods Identification				Quantity and type of packing	Packing Inst.	Authorization
Proper Shipping Name	Class or Division	UN or ID No.	Subsidiary Risk			
LITHIUM BATTERIES CONTAINED IN EQUIPMENT	9	UN3091		1 PLASTIC BOX X 55 GRAMS	912 II	PER CA-9206009

**Additional Handling Information**

1 HERMIT SERIES DATALOGGER X 55 GRAMS (11 GRAMS/CELL)

I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in the proper condition for transport by air according to the applicable International and National Government Regulations.

Name/Title of Signatory

Place and Date

Signature  
(see warning above)

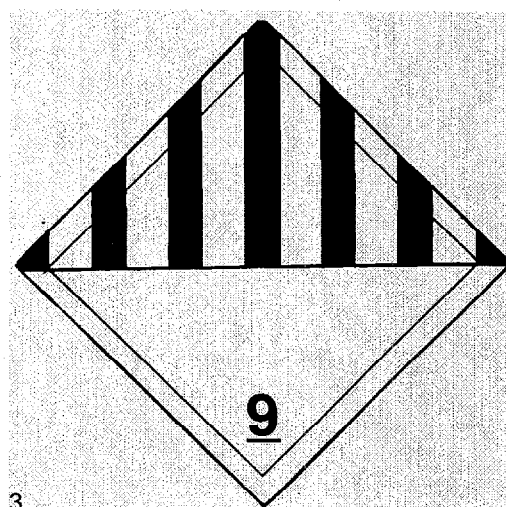
Emergency Telephone Number (Required for US Origin or Destination Shipments)

800-535-5053

IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.

Subject NON-RADIOLOGICAL SAMPLE HANDLING	Number SA-6.1	Page 24 of 24
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**ATTACHMENT G (CONTINUED)  
LITHIUM BATTERY SHIPPING PAPERS**



**LITHIUM BATTERIES CONTAINED  
IN EQUIPMENT.  
UN-3091.  
SHIPPED UNDER CA-9206009**



TETRA TECH NUS, INC.

# STANDARD OPERATING PROCEDURES

Number

SA-6.3

Page

1 of 37

Effective Date

01/00

Revision

1

Applicability

Tetra Tech NUS, Inc.

Prepared

Earth Sciences Department

Subject

FIELD DOCUMENTATION

Approved

D. Senovich

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## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and designate the field data record forms, logs and reports generally initiated and maintained for documenting Tetra Tech NUS field activities.

## 2.0 SCOPE

Documents presented within this procedure (or equivalents) shall be used for all Tetra Tech NUS field activities, as applicable. Other or additional documents may be required by specific client contracts or project planning documents.

## 3.0 GLOSSARY

None

## 4.0 RESPONSIBILITIES

Project Manager (PM) - The Project Manager is responsible for obtaining hardbound, controlled-distribution logbooks (from the appropriate source), as needed. In addition, the Project Manager is responsible for placing all field documentation used in site activities (i.e., records, field reports, sample data sheets, field notebooks, and the site logbook) in the project's central file upon the completion of field work.

Field Operations Leader (FOL) - The Field Operations Leader is responsible for ensuring that the site logbook, notebooks, and all appropriate and current forms and field reports illustrated in this guideline (and any additional forms required by the contract) are correctly used, accurately filled out, and completed in the required time-frame.

## 5.0 PROCEDURES

### 5.1 Site Logbook

#### 5.1.1 General

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major onsite activities are documented. At a minimum, the following activities/events shall be recorded or referenced (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start and/or completion of borehole, trench, monitoring well installation, etc.
- Daily onsite activities performed each day
- Sample pickup information
- Health and Safety issues (level of protection observed, etc.)
- Weather conditions

A site logbook shall be maintained for each project. The site logbook shall be initiated at the start of the first onsite activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that onsite activities take place which involve Tetra Tech NUS or subcontractor personnel. Upon completion of the fieldwork, the site logbook must become part of the project's central file.

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The following information must be recorded on the cover of each site logbook:

- Project name
- Tetra Tech NUS project number
- Sequential book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks (see Section 5.2), but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). An example of a typical site logbook entry is shown in Attachment A.

If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the field notebook in which the measurements are recorded (see Attachment A).

All logbook, notebook, and log sheet entries shall be made in indelible ink (black pen is preferred). No erasures are permitted. If an incorrect entry is made, the data shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook pages used must be signed and dated. The site logbook must also be signed by the Field Operations Leader at the end of each day.

**5.1.2      Photographs**

When movies, slides, or photographs are taken of a site or any monitoring location, they must be numbered sequentially to correspond to logbook/notebook entries. The name of the photographer, date, time, site location, site description, and weather conditions must be entered in the logbook/notebook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook/notebook. If possible, such techniques shall be avoided, since they can adversely affect the accuracy of photographs. Chain-of-custody procedures depend upon the subject matter, type of film, and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Once processed, the slides of photographic prints shall be consecutively numbered and labeled according to the logbook/notebook descriptions. The site photographs and associated negatives must be docketed into the project's central file.

**5.2              Field Notebooks**

Key field team personnel may maintain a separate dedicated field notebook to document the pertinent field activities conducted directly under their supervision. For example, on large projects with multiple investigative sites and varying operating conditions, the Health and Safety Officer may elect to maintain a separate field notebook. Where several drill rigs are in operation simultaneously, each site geologist assigned to oversee a rig must maintain a field notebook.

**5.3              Sample Forms**

A summary of the forms illustrated in this procedure is shown as the listing of Attachments in the Table of Contents for this SOP. Forms may be altered or revised for project-specific needs contingent upon client

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approval. Care must be taken to ensure that all essential information can be documented. Guidelines for completing these forms can be found in the related sampling SOP.

### **5.3.1 Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results**

#### **5.3.1.1 Sample Log Sheet**

Sample Log Sheets are used to record specified types of data while sampling. Attachments B-1 to B-4 are examples of Sample Log Sheets. The data recorded on these sheets are useful in describing the waste source and sample as well as pointing out any problems, difficulties, or irregularities encountered during sampling. A log sheet must be completed for each sample obtained, including field quality control (QC) samples.

#### **5.3.1.2 Sample Label**

A typical sample label is illustrated in Attachment B-5. Adhesive labels must be completed and applied to every sample container. Sample labels can usually be obtained from the appropriate Program source electronically generated in-house, or are supplied from the laboratory subcontractor.

#### **5.3.1.3 Chain-of-Custody Record Form**

The Chain-of-Custody (COC) Record is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. This form must be used for any samples collected for chemical or geotechnical analysis whether the analyses are performed on site or off site. One carbonless copy of the completed COC form is retained by the field crew, one copy is sent to the Project Manager, while the original is sent to the laboratory. The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the first cooler. The COC form should then state how many coolers are included with that shipment. An example of a Chain-of-Custody Record form is provided as Attachment B-6. Once the samples are received at the laboratory, the sample cooler and contents are checked and any problems are noted on the enclosed COC form (any discrepancies between the sample labels and COC form and any other problems that are noted are resolved through communication between the laboratory point-of-contact and the Tetra Tech NUS Project Manager). The COC form is signed and copied. The laboratory will retain the copy while the original becomes part of the samples' corresponding analytical data package.

#### **5.3.1.4 Chain-of-Custody Seal**

Attachment B-7 is an example of a custody seal. The Custody seal is an adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transport to the laboratory. The COC seals are signed and dated by the samplers and affixed across the opening edges of each cooler containing environmental samples. COC seals may be available from the laboratory; these seals may also be purchased from a supplier.

#### **5.3.1.5 Field Analytical Log Sheets for Geochemical Parameters**

Field Analytical Log Sheets (Attachment B-8) are used to record geochemical and/or natural attenuation field test results. Attachments B-8 (3-page form) should be used when applicable.

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**5.3.2 Hydrogeological and Geotechnical Forms**

**5.3.2.1 Groundwater Level Measurement Sheet**

A groundwater level measurement sheet, shown in Attachment C-1 must be filled out for each round of water level measurements made at a site.

**5.3.2.2 Data Sheet for Pumping Test**

During the performance of a pumping test (or an in-situ hydraulic conductivity test), a large amount of data must be recorded, often within a short time period. The pumping test data sheet (Attachment C-2) facilitates this task by standardizing the data collection format, and allowing the time interval for collection to be laid out in advance.

**5.3.2.3 Packer Test Report Form**

A packer test report form shown in Attachment C-3 must be completed for each well upon which a packer test is conducted.

**5.3.2.4 Summary Log of Boring**

During the progress of each boring, a log of the materials encountered, operation and driving of casing, and location of samples must be kept. The Summary Log of Boring, or Boring Log, (Attachment C-4) is used for this purpose and must be completed for each soil boring performed. In addition, if volatile organics are monitored on cores, samples, cuttings from the borehole, or breathing zone, (using a PID or FID), these results must be entered on the boring log at the appropriate depth. The "Remarks" column can be used to subsequently enter the laboratory sample number, the concentration of key analytical results, or other pertinent information. This feature allows direct comparison of contaminant concentrations with soil characteristics.

**5.3.2.5 Monitoring Well Construction Details Form**

A Monitoring Well Construction Details Form must be completed for every monitoring well, piezometer, or temporary well point installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter pack, annular seal and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation, or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock), different forms are used (see Attachments C-5 through C-9). Similar forms are used for flush-mount well completions.

**5.3.2.6 Test Pit Log**

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log (Attachment C-10) must be filled out by the responsible field geologist or sampling technician.

**5.3.2.7 Miscellaneous Monitoring Well Forms**

Monitoring Well Materials Certificate of Conformance (Attachment C-11) should be used as the project directs to document all materials utilized during each monitoring well installation.

The Monitoring Well Development Record (Attachment C-12) should be used as the project directs to document all well development activities.

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### 5.3.3 Equipment Calibration and Maintenance Form

The calibration or standardization of monitoring, measuring or test equipment is necessary to assure the proper operation and response of the equipment, to document the accuracy, precision or sensitivity of the measurement, and determine if correction should be applied to the readings. Some items of equipment require frequent calibration, others infrequent. Some are calibrated by the manufacturer, others by the user.

Each instrument requiring calibration has its own Equipment Calibration Log (Attachment D) which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device used in the field; entries must be made for each day the equipment is used.

### 5.4 Field Reports

The primary means of recording onsite activities is the site logbook. Other field notebooks may also be maintained. These logbooks and notebooks (and supporting forms) contain detailed information required for data interpretation or documentation, but are not easily useful for tracking and reporting of progress. Furthermore, the field logbook/notebooks remain onsite for extended periods of time and are thus not accessible for timely review by project management.

#### 5.4.1 Daily Activities Report

To provide timely oversight of onsite contractors, Daily Activities Reports are completed and submitted as described below.

##### 5.4.1.1 Description

The Daily Activities Report (DAR) documents the activities and progress for each day's field work. This report must be filled out on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring which involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors (Attachment E is an example of a Daily Activities Report).

##### 5.4.1.2 Responsibilities

It is the responsibility of the rig geologist to complete the DAR and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

##### 5.4.1.3 Submittal and Approval

At the end of the shift, the rig geologist must submit the Daily Activities Report to the Field Operations Leader (FOL) for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The DAR reports are retained by the FOL for use in preparing the site logbook and in preparing weekly status reports for submission to the Project Manager.

### 5.4.2 Weekly Status Reports

To facilitate timely review by project management, photocopies of logbook/notebook entries may be made for internal use.

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It should be noted that in addition to the summaries described herein, other summary reports may also be contractually required. Attachment F is an example of a Field Trip Summary Report form.

## 6.0 ATTACHMENTS

Attachment A	TYPICAL SITE LOGBOOK ENTRY
Attachment B-1	EXAMPLE GROUNDWATER SAMPLE LOG SHEET
Attachment B-2	EXAMPLE SURFACE WATER SAMPLE LOG SHEET
Attachment B-3	EXAMPLE SOIL/SEDIMENT SAMPLE LOG SHEET
Attachment B-4	CONTAINER SAMPLE LOG SHEET FORM
Attachment B-5	SAMPLE LABEL
Attachment B-6	CHAIN-OF-CUSTODY RECORD FORM
Attachment B-7	CHAIN-OF-CUSTODY SEAL
Attachment B-8	FIELD ANALYTICAL LOG SHEET
Attachment C-1	EXAMPLE GROUNDWATER LEVEL MEASUREMENT SHEET
Attachment C-2	EXAMPLE PUMPING TEST DATA SHEET
Attachment C-3	PACKER TEST REPORT FORM
Attachment C-4	EXAMPLE BORING LOG
Attachment C-5	EXAMPLE OVERBURDEN MONITORING WELL SHEET
Attachment C-5A	EXAMPLE OVERBURDEN MONITORING WELL SHEET (FLUSHMOUNT)
Attachment C-6	EXAMPLE CONFINING LAYER MONITORING WELL SHEET
Attachment C-7	EXAMPLE BEDROCK MONITORING WELL SHEET - OPEN HOLE WELL
Attachment C-8	EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK
Attachment C-9	EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK (FLUSHMOUNT)
Attachment C-10	EXAMPLE TEST PIT LOG
Attachment C-11	MONITORING WELL MATERIALS CERTIFICATE OF CONFORMANCE
Attachment C-12	MONITORING WELL DEVELOPMENT RECORD
Attachment D	EXAMPLE EQUIPMENT CALIBRATION LOG
Attachment E	EXAMPLE DAILY ACTIVITIES RECORD
Attachment F	FIELD TRIP SUMMARY REPORT

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**ATTACHMENT A  
TYPICAL SITE LOGBOOK ENTRY**

START TIME: \_\_\_\_\_ DATE: \_\_\_\_\_

SITE LEADER: \_\_\_\_\_

PERSONNEL: \_\_\_\_\_

TINUS	DRILLER	SITE VISITORS
_____	_____	_____
_____	_____	_____
_____	_____	_____

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenney and fire hoses were set up.
2. Drilling activities at well \_\_\_\_\_ resumes. Rig geologist was \_\_\_\_\_. See Geologist's Notebook, No. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected; see sample logbook, page 42. Drilling activities completed at 11:50 and a 4-inch stainless steel well installed. See Geologist's Notebook, No. 1, page 31, and well construction details for well \_\_\_\_\_.
3. Drilling rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well \_\_\_\_\_.
4. Well \_\_\_\_\_ drilled. Rig geologist was \_\_\_\_\_. See Geologist's Notebook, No. 2, page \_\_\_\_\_ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.
5. Well \_\_\_\_\_ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for 1 hour. At the end of the hour, water pumped from well was "sand free."
6. EPA remedial project manger arrives on site at 14:25 hours.
7. Large dump truck arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up over test pit \_\_\_\_\_.
8. Test pit \_\_\_\_\_ dug with cuttings placed in dump truck. Rig geologist was \_\_\_\_\_. See Geologist's Notebook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow groundwater table, filling in of test pit \_\_\_\_\_ resulted in a very soft and wet area. A mound was developed and the area roped off.
9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel off site, gate locked.


\_\_\_\_\_  
Field Operations Leader



[illegible]

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## ATTACHMENT B-2

	Tetra Tech NUS, Inc.	<b>SURFACE WATER SAMPLE LOG SHEET</b>	Page _____ of _____
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Project Site Name: _____ Project No.: _____  <input type="checkbox"/> Stream <input type="checkbox"/> Spring <input type="checkbox"/> Pond <input type="checkbox"/> Lake <input type="checkbox"/> Other: _____ <input type="checkbox"/> QA Sample Type: _____	Sample ID No.: _____ Sample Location: _____ Sampled By: _____ C.O.C. No.: _____  Type of Sample: <input type="checkbox"/> Low Concentration <input type="checkbox"/> High Concentration
---	--

SAMPLING DATA:								
Date:	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (‰)	Other
Time:								
Depth:								
Method:								

SAMPLE COLLECTION INFORMATION:			
Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:	MAP:

Circle if Applicable:     MS/MSD     Duplicate ID No.: _____	Signature(s): _____
--	---------------------

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### ATTACHMENT B-3



Tetra Tech NUS, Inc.

### SOIL & SEDIMENT SAMPLE LOG SHEET

Page      of     

Project Site Name: _____		Sample ID No.: _____	
Project No.: _____		Sample Location: _____	
<input type="checkbox"/> Surface Soil <input type="checkbox"/> Subsurface Soil <input type="checkbox"/> Sediment <input type="checkbox"/> Other: _____ <input type="checkbox"/> QA Sample Type: _____		Sampled By: _____ C.O.C. No.: _____  Type of Sample: <input type="checkbox"/> Low Concentration <input type="checkbox"/> High Concentration	

GRAB SAMPLE DATA:			
Date: _____	Depth Interval _____	Color _____	Description (Sand, Silt, Clay, Moisture, etc.) _____
Time: _____			
Method: _____			
Monitor Reading (ppm): _____			

COMPOSITE SAMPLE DATA:				
Date: _____	Time _____	Depth Interval _____	Color _____	Description (Sand, Silt, Clay, Moisture, etc.) _____
Method: _____				
Monitor Readings (Range in ppm): _____				

SAMPLE COLLECTION INFORMATION:			
Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:		MAP:
<div style="height: 100px;"></div>		<div style="height: 100px;"></div>
Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	

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**ATTACHMENT B-4**



Tetra Tech NUS, Inc.


**CONTAINER SAMPLE & INSPECTION SHEET**

Page \_\_\_\_\_ of \_\_\_\_\_

Project Site Name: _____ Project Number: _____ Site Identification: _____ Container Number(s): _____ Sample Type: <input type="checkbox"/> Grab <input type="checkbox"/> Composite		Sample ID No. _____ Sampled By: _____ C.O.C. No. _____ Concentration: <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low																					
<b>CONTAINER SOURCE</b>		<b>CONTAINER DESCRIPTION</b>																					
<b>DRUM:</b> <input type="checkbox"/> Bung Top <input type="checkbox"/> Lever Lock <input type="checkbox"/> Bolted Ring <input type="checkbox"/> Other _____		<b>COLOR:</b> _____  <b>CONDITION:</b> _____																					
<b>TANK:</b> <input type="checkbox"/> Plastic <input type="checkbox"/> Metal <input type="checkbox"/> Other _____		<b>MARKINGS:</b> _____  <b>VOL OF CONTENTS:</b> _____																					
<b>OTHER:</b> _____		<b>OTHER:</b> _____																					
<b>CONTAINER DISPOSITION</b>		<b>CONTENTS DESCRIPTION</b>																					
<b>SAMPLED:</b> _____  <b>OPENED BUT NOT SAMPLED:</b> Reason _____ _____  <b>NOT OPENED:</b> Reason _____ _____		<b>SINGLE PHASED:</b> _____ _____  <b>MULTIPHASE :</b> <table border="0"> <tr> <td></td> <td align="center"><b>Layer 1</b></td> <td align="center"><b>Layer 2</b></td> <td align="center"><b>Layer 3</b></td> </tr> <tr> <td>Phase (Sol. or Liq.)</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Color</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Viscosity</td> <td>L M or H</td> <td>L M or H</td> <td>L M or H</td> </tr> <tr> <td>% of Total Volume</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </table>			<b>Layer 1</b>	<b>Layer 2</b>	<b>Layer 3</b>	Phase (Sol. or Liq.)	_____	_____	_____	Color	_____	_____	_____	Viscosity	L M or H	L M or H	L M or H	% of Total Volume	_____	_____	_____
	<b>Layer 1</b>	<b>Layer 2</b>	<b>Layer 3</b>																				
Phase (Sol. or Liq.)	_____	_____	_____																				
Color	_____	_____	_____																				
Viscosity	L M or H	L M or H	L M or H																				
% of Total Volume	_____	_____	_____																				
<b>MONITOR READING:</b>		<b>SAMPLE and /or INSPECTION DATE &amp; TIME:</b>																					
		_____ HRS.																					
<b>METHOD:</b>		<b>ANALYSIS:</b>																					
<b>SAMPLER(S) and / or INSPECTOR(S) SIGNATURE:</b>																							

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**ATTACHMENT B-5**

 Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090		Project:	
		Site:	
		Location:	
Sample No:		Matrix:	
Date:	Time:	Preserve:	
Analysis:			
Sampled by:		Laboratory:	



Effective Date  
01/00

3/99  
FORM NO. TtNUS-001

Tetra Tech NUS, Inc.

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ATTACHMENT B-7

CHAIN-OF-CUSTODY SEAL

<b>Signature</b> <hr/>		<b>CUSTODY SEAL</b> <hr/>
<b>Date</b> <hr/>		<b>Date</b> <hr/>
<b>CUSTODY SEAL</b> <hr/>		<b>Signature</b> <hr/>

Subject  <div style="text-align: center; font-weight: bold;">FIELD DOCUMENTATION</div>	Number <div style="text-align: center;">SA-6.3</div>	Page <div style="text-align: center;">17 of 37</div>
	Revision <div style="text-align: center;">1</div>	Effective Date <div style="text-align: center;">01/00</div>

ATTACHMENT B-8

**FIELD ANALYTICAL LOG SHEET**  
**GEOCHEMICAL PARAMETERS**

Page      of

Tetra Tech NUS, Inc.

Project Site Name: \_\_\_\_\_

Project No.: \_\_\_\_\_

Sampled By: \_\_\_\_\_

Field Analyst: \_\_\_\_\_

Field Form Checked as per QA/QC Checklist (initials): \_\_\_\_\_

Sample ID No.: \_\_\_\_\_

Sample Location: \_\_\_\_\_

Duplicate: ☐

Blank: ☐

**SAMPLING DATA:**

Date:	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/L)	Salinity (%)	Other
Time: _____	_____	_____	_____	_____	_____	_____	_____	_____
Method: _____	_____	_____	_____	_____	_____	_____	_____	_____

**SAMPLE COLLECTION/ANALYSIS INFORMATION:**

ORP (Eh) (+/- mv): \_\_\_\_\_ Electrode Make & Model: \_\_\_\_\_

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

**Dissolved Oxygen:**

Equipment: HACH Digital Titrator OX-DT      CHEMetrics (Range: \_\_\_\_\_ mg/L)      Analysis Time: \_\_\_\_\_

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
<input type="checkbox"/>	1-5 mg/L	200 ml	0.200 N	0.01	_____	x 0.01	= _____ mg/L
<input type="checkbox"/>	2-10 mg/L	100 ml	0.200 N	0.02	_____	x 0.02	= _____ mg/L

CHEMetrics: \_\_\_\_\_ mg/L

Notes: \_\_\_\_\_

**Alkalinity:**

Equipment: HACH Digital Titrator AL-DT      CHEMetrics (Range: \_\_\_\_\_ mg/L)      Analysis Time: \_\_\_\_\_

Filtered: ☐

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
<input type="checkbox"/>	10-40 mg/L	100 ml	0.1800 N	0.1	_____ & _____	x 0.1	= _____ mg/L
<input type="checkbox"/>	40-160 mg/L	25 ml	0.1800 N	0.4	_____ & _____	x 0.4	= _____ mg/L
<input type="checkbox"/>	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0	= _____ mg/L
<input type="checkbox"/>	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0	= _____ mg/L
<input type="checkbox"/>	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0	= _____ mg/L
<input type="checkbox"/>	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0	= _____ mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:	_____	_____	_____

CHEMetrics: \_\_\_\_\_ mg/L

Notes: \_\_\_\_\_

Standard Additions: ☐      Titrant Molarity: \_\_\_\_\_      Digits Required: 1st.: \_\_\_\_\_ 2nd.: \_\_\_\_\_ 3rd.: \_\_\_\_\_

**Carbon Dioxide:**

Equipment: HACH Digital Titrator CA-DT      CHEMetrics (Range: \_\_\_\_\_ mg/L)      Analysis Time: \_\_\_\_\_

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
<input type="checkbox"/>	10-50 mg/L	200 ml	0.3636 N	0.1	_____	x 0.1	= _____ mg/L
<input type="checkbox"/>	20-100 mg/L	100 ml	0.3636 N	0.2	_____	x 0.2	= _____ mg/L
<input type="checkbox"/>	100-400 mg/L	200 ml	3.636 N	1.0	_____	x 1.0	= _____ mg/L
<input type="checkbox"/>	200-1000 mg/L	100 ml	3.636 N	2.0	_____	x 2.0	= _____ mg/L

CHEMetrics: \_\_\_\_\_ mg/L


Notes: \_\_\_\_\_

Standard Additions: ☐      Titrant Molarity: \_\_\_\_\_      Digits Required: 1st.: \_\_\_\_\_ 2nd.: \_\_\_\_\_ 3rd.: \_\_\_\_\_




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**ATTACHMENT B-8 (Continued)**

		<b>FIELD ANALYTICAL LOG SHEET</b> <b>GEOCHEMICAL PARAMETERS</b>		Page <u>  </u> of <u>  </u>
Tetra Tech NUS, Inc.				
Project Site Name: _____		Sample ID No.: _____		
Project No.: _____		Sample Location: _____		
Sampled By: _____		Duplicate: <input type="checkbox"/>		
Field Analyst: _____		Blank: <input type="checkbox"/>		
Field Form Checked as per QA/QC Checklist (initials): <span style="border: 1px solid black; padding: 2px 10px;"> </span>				
<b>SAMPLE COLLECTION/ANALYSIS INFORMATION:</b>				
<b>Sulfide (S<sup>2-</sup>):</b>				
Equipment: DR-700	DR-8 <u>  </u>	HS-WR Color Wheel	Other: _____	Analysis Time: _____
Program/Module: 610nm	93			
Concentration: _____ mg/L				Filtered: <input type="checkbox"/>
Notes: _____				
<b>Sulfate (SO<sub>4</sub><sup>2-</sup>):</b>				
Equipment: DR-700	DR-8 <u>  </u>	Other: _____		Analysis Time: _____
Program/Module: 91				
Concentration: _____ mg/L				Filtered: <input type="checkbox"/>
Standard Solution: <input type="checkbox"/>	Results: _____			
Standard Additions: <input type="checkbox"/>	Digits Required: 0.1ml: _____ 0.2ml: _____ 0.3ml: _____			
Notes: _____				
<b>Nitrite (NO<sub>2</sub><sup>-</sup>-N):</b>				
Equipment: DR-700	DR-8 <u>  </u>	Other: _____		Analysis Time: _____
Program/Module: 60				
Concentration: _____ mg/L				Filtered: <input type="checkbox"/>
			Reagent Blank Correction: <input type="checkbox"/>	
			Standard Solution: <input type="checkbox"/> Results: <input type="checkbox"/>	
Notes: _____				
<b>Nitrate (NO<sub>3</sub><sup>-</sup>-N):</b>				
Equipment: DR-700	DR-8 <u>  </u>	Other: _____		Analysis Time: _____
Program/Module: 55				
Concentration: _____ mg/L				Filtered: <input type="checkbox"/>
			Nitrite Interference Treatment: <input type="checkbox"/>	
			Reagent Blank Correction: <input type="checkbox"/>	
Standard Solution: <input type="checkbox"/>	Results: _____			
Standard Additions: <input type="checkbox"/>	Digits Required: 0.1ml: _____ 0.2ml: _____ 0.3ml: _____			
Notes: _____				

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**ATTACHMENT B-8 (Continued)**

		<b>FIELD ANALYTICAL LOG SHEET</b> <b>GEOCHEMICAL PARAMETERS</b>		Page ____ of ____
Tetra Tech NUS, Inc.				
Project Site Name: _____ Project No.: _____ Sampled By: _____ Field Analyst: _____		Sample ID No.: _____ Sample Location: _____ Duplicate: <input type="checkbox"/> Blank: <input type="checkbox"/> Field Form Checked as per QA/QC Checklist (initials): <input type="checkbox"/>		
SAMPLE COLLECTION/ANALYSIS INFORMATION:				
<b>Manganese (Mn<sup>2+</sup>):</b> Equipment: DR-700      DR-8 ____      HACH MN-5      Other: _____      Analysis Time: _____ Program/Module: 525nm      41 Concentration: _____ mg/L Standard Solution: <input type="checkbox"/> Results: _____      Reagent Blank Correction: <input type="checkbox"/> Standard Additions: <input type="checkbox"/> Digits Required: 0.1ml: _____ 0.2ml: _____ 0.3ml: _____ Notes: _____				
<b>Ferrous Iron (Fe<sup>2+</sup>):</b> Equipment: DR-700      DR-8 ____      IR-18C Color Wheel      Other: _____      Analysis Time: _____ Program/Module: 500nm      33 Concentration: _____ mg/L Filtered: <input type="checkbox"/> Notes: _____				
<b>Hydrogen Sulfide (H<sub>2</sub>S):</b> Equipment: HS-C      Other: _____      Analysis Time: _____ Concentration: _____ mg/L      Exceeded 5.0 mg/L range on color chart: <input type="checkbox"/> Notes: _____				
<b>QA/QC Checklist:</b> All data fields have been completed as necessary: <input type="checkbox"/> Correct measurement units are cited in the SAMPLING DATA block: <input type="checkbox"/> Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: <input type="checkbox"/> Multiplication is correct for each <i>Multiplier</i> table: <input type="checkbox"/> Final calculated concentration is within the appropriate <i>Range Used</i> block: <input type="checkbox"/> Alkalinity <i>Relationship</i> is determined appropriately as per manufacturer (HACH) instructions: <input type="checkbox"/> QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: <input type="checkbox"/> Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: <input type="checkbox"/> Title block on each page of form is initialized by person who performed this QA/QC Checklist: <input type="checkbox"/>				











## ATTACHMENT C4 (Continued)

LEGEND  
SOIL TERMS

COARSE-GRAINED SOILS					UNIFIED SOIL CLASSIFICATION (USCS)					FINE-GRAINED SOILS				
More Than Half of Material is LARGER Than No. 200 Sieve Size					More Than Half of Material is SMALLER Than No. 200 Sieve Size									
FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)			GROUP SYMBOL	TYPICAL NAMES		FIELD IDENTIFICATION PROCEDURES (Excluding Particles Larger Than 3 Inches and Basing Fractions on Estimated Weights)			GROUP SYMBOL	TYPICAL NAMES				
						Identification Procedures on Fraction Smaller than No. 40 Sieve Size								
GRAVELS (50% (+)>1/4" ø)	CLEAN GRAVELS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Well graded gravels, gravel-sand mixtures, little or no fines.	SILTS AND CLAYS Liquid Limit <50	None to Slight	Quick to Slow	None	ML	Inorganic silts and very fine sands; rock flour, silty or clayey fine sands with slight plasticity.				
		Predominantly one size or a range of sizes with some intermediate sizes missing.	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.		Medium to High	None to Very Slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.				
	GRAVELS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see ML)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.		Slight to Medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity.				
		Plastic fines (for identification procedures, see CL)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.	Slight to Medium	Slow to None	Slight to Medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.					
SANDS 50% (+)<1/4" ø	CLEAN SANDS (Low % Fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines.	SILTS AND CLAYS Liquid Limit >50	High to Very High	None	High	CH	Inorganic clays of high plasticity, fat clays.				
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines.		Medium to High	None to Very Slow	Slight to Medium	OH	Organic clays of medium to high plasticity.				
	SANDS W/FINES (High % Fines)	Non-plastic fines (for identification procedures, see MCL)	SM	Silty sands, poorly graded sand-silt mixtures.	HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			PI	Peat and other organic soils				
		Plastic fines (for identification procedures, see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.										

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example, GW-GC, well graded gravel-sand mixture with clay binder.  
All sieve sizes on this chart are U.S. Standard.

DENSITY OF GRANULAR SOILS	
DESIGNATION	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT
Very Loose	0-4
Loose	5-10
Medium Loose	11-30
Dense	31-50
Very Dense	Over 50

CONSISTENCY OF COHESIVE SOILS			
CONSISTENCY	UNC. COMPRESSIVE STRENGTH (TONS/SQ. FT.)	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very Soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist.
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb.
Medium Stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb.
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb.
Very Stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail.
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail.

## ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)			ROCK BROKENESS		
Descriptive Terms	Screwdriver or Knife Effects	Hammer Effects	Descriptive Terms	Abbreviation	Spacing
Soft	Easily gouged	Crushes when pressed with hammer.	Very Broken	(V. Br.)	0-2"
Medium Soft	Can be gouged	Breaks (one blow); crumbly edges	Broken	(Br.)	2'-1"
Medium Hard	Can be scratched	Breaks (one blow); sharp edges	Blocky	(Bl.)	1'-3"
Hard	Cannot be scratched	Breaks conchoidally (several blows); sharp edges	Massive	(M.)	3'-10"

## LEGEND:

## SOIL SAMPLES - TYPES

5-2" Split-Barrel Sample  
ST-3" O.D. Undisturbed Sample  
O - Other Samples, Specify in Remarks.

## ROCK SAMPLES - TYPES

X-NX (Conventional) Core (-2-1/8" O.D.)  
Q-NQ (Wireline) Core (-1-7/8" O.D.)  
Z - Other Core Sizes, Specify in Remarks


## WATER LEVELS

12/18  
V.12.8 Initial Level w/Date & Depth

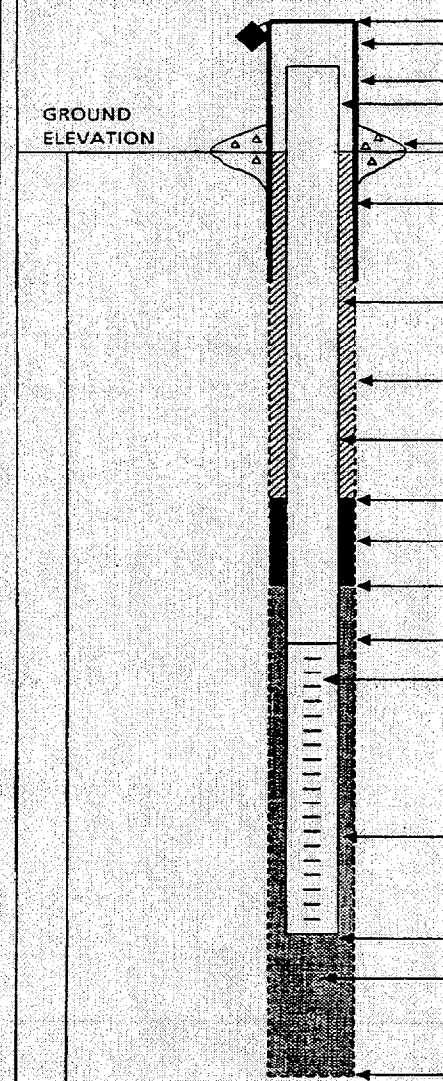
12/18

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**ATTACHMENT C-5  
EXAMPLE OVERBURDEN MONITORING WELL SHEET**

 <div style="display: inline-block; vertical-align: middle; text-align: center;"> <b>OVERBURDEN MONITORING WELL SHEET</b> </div>		BORING NO.: _____
PROJECT _____ PROJECT NO. _____ ELEVATION _____ FIELD GEOLOGIST _____	LOCATION _____ BORING _____ DATE _____	DRILLER _____ DRILLING _____ METHOD _____ DEVELOPMENT _____ METHOD _____



ELEVATION OF TOP OF SURFACE CASING : \_\_\_\_\_

ELEVATION OF TOP OF RISER PIPE: \_\_\_\_\_

STICK - UP TOP OF SURFACE CASING \_\_\_\_\_

STICK - UP RISER PIPE : \_\_\_\_\_

TYPE OF SURFACE SEAL: \_\_\_\_\_

I.D. OF SURFACE CASING: \_\_\_\_\_

TYPE OF SURFACE CASING: \_\_\_\_\_

RISER PIPE I.D. \_\_\_\_\_

TYPE OF RISER PIPE: \_\_\_\_\_

BOREHOLE DIAMETER: \_\_\_\_\_

TYPE OF BACKFILL: \_\_\_\_\_

ELEVATION / DEPTH TOP OF SEAL: \_\_\_\_\_ / \_\_\_\_\_

TYPE OF SEAL: \_\_\_\_\_

DEPTH TOP OF SAND PACK: \_\_\_\_\_

ELEVATION / DEPTH TOP OF SCREEN: \_\_\_\_\_ / \_\_\_\_\_

TYPE OF SCREEN: \_\_\_\_\_

SLOT SIZE x LENGTH: \_\_\_\_\_

I.D. OF SCREEN: \_\_\_\_\_

TYPE OF SAND PACK: \_\_\_\_\_

ELEVATION / DEPTH BOTTOM OF SCREEN: \_\_\_\_\_ / \_\_\_\_\_

ELEVATION / DEPTH BOTTOM OF SAND PACK: \_\_\_\_\_ / \_\_\_\_\_


TYPE OF BACKFILL BELOW OBSERVATION WELL: \_\_\_\_\_

ELEVATION / DEPTH OF HOLE: \_\_\_\_\_ / \_\_\_\_\_

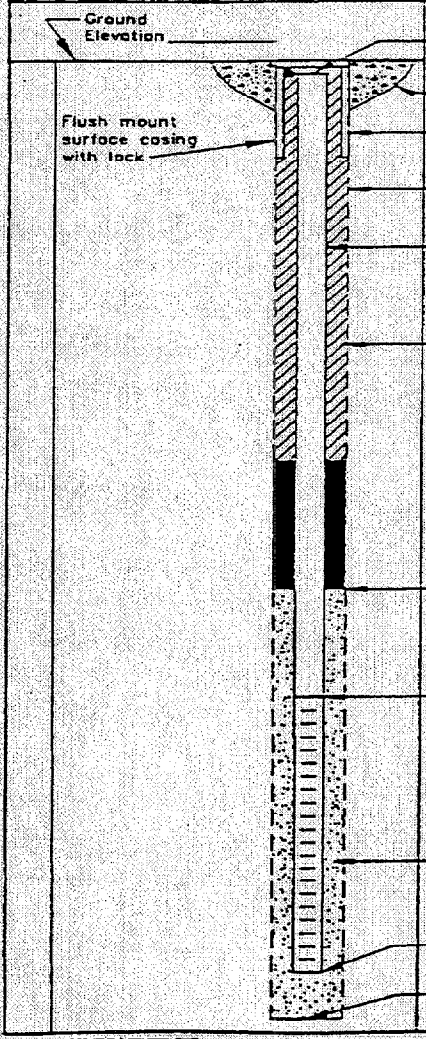


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**ATTACHMENT C-5A  
EXAMPLE OVERBURDEN MONITORING WELL SHEET (FLUSHMOUNT)**

 <span style="font-size: 1.2em; font-weight: bold; margin-left: 10px;">MONITORING WELL SHEET</span>		BORING NO.: _____
PROJECT _____ PROJECT NO. _____ ELEVATION _____ FIELD GEOLOGIST _____	LOCATION _____ BORING _____ DATE _____	DRILLER _____ DRILLING _____ METHOD _____ DEVELOPMENT _____ METHOD _____



ELEVATION TOP OF RISER: \_\_\_\_\_

TYPE OF SURFACE SEAL: \_\_\_\_\_

TYPE OF PROTECTIVE CASING: \_\_\_\_\_

I.D. OF PROTECTIVE CASING: \_\_\_\_\_

DIAMETER OF HOLE: \_\_\_\_\_

TYPE OF RISER PIPE: \_\_\_\_\_

RISER PIPE I.D.: \_\_\_\_\_

TYPE OF BACKFILL/SEAL: \_\_\_\_\_

DEPTH/ELEVATION TOP OF SAND: \_\_\_\_\_

DEPTH/ELEVATION TOP OF SCREEN: \_\_\_\_\_

TYPE OF SCREEN: \_\_\_\_\_

SLOT SIZE x LENGTH: \_\_\_\_\_

TYPE OF SAND PACK: \_\_\_\_\_

DIAMETER OF HOLE IN BEDROCK: \_\_\_\_\_


DEPTH/ELEVATION BOTTOM OF SCREEN: \_\_\_\_\_

DEPTH/ELEVATION BOTTOM OF SAND: \_\_\_\_\_

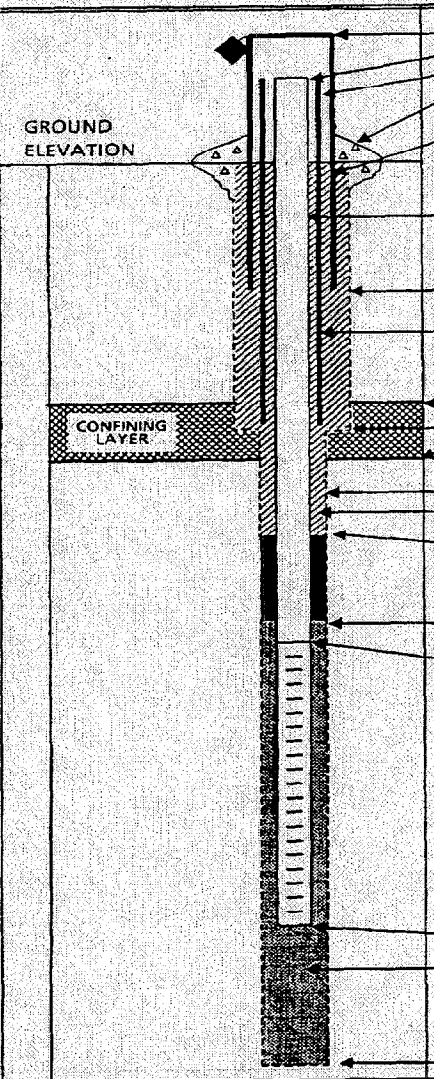
DEPTH/ELEVATION BOTTOM OF HOLE: \_\_\_\_\_

BACKFILL MATERIAL BELOW SAND: \_\_\_\_\_

**ATTACHMENT C-6**  
**EXAMPLE CONFINING LAYER MONITORING WELL SHEET**

		BORING NO. : _____	
		<b>CONFINING LAYER MONITORING WELL SHEET</b>	
PROJECT _____	LOCATION _____	DRILLER _____	
PROJECT NO. _____	BORING _____	DRILLING _____	
ELEVATION _____	DATE _____	METHOD _____	
FIELD GEOLOGIST _____		DEVELOPMENT _____	
		METHOD _____	



ELEVATION OF TOP OF SURFACE CASING : \_\_\_\_\_

ELEVATION OF TOP OF RISER PIPE: \_\_\_\_\_

ELEVATION TOP OF PERM. CASING: \_\_\_\_\_

TYPE OF SURFACE SEAL: \_\_\_\_\_

I.D. OF SURFACE CASING: \_\_\_\_\_

TYPE OF SURFACE CASING: \_\_\_\_\_

RISER PIPE I.D. \_\_\_\_\_

TYPE OF RISER PIPE: \_\_\_\_\_

BOREHOLE DIAMETER: \_\_\_\_\_

PERM. CASING I.D. \_\_\_\_\_

TYPE OF CASING & BACKFILL: \_\_\_\_\_

ELEVATION / DEPTH TOP CONFINING LAYER: \_\_\_\_\_

ELEVATION / DEPTH BOTTOM OF CASING: \_\_\_\_\_

ELEVATION / DEPTH BOT. CONFINING LAYER: \_\_\_\_\_

BOREHOLE DIA. BELOW CASING: \_\_\_\_\_

TYPE OF BACKFILL: \_\_\_\_\_

ELEVATION / DEPTH TOP OF SEAL: \_\_\_\_\_

TYPE OF SEAL: \_\_\_\_\_

DEPTH TOP OF SAND PACK: \_\_\_\_\_

ELEVATION/DEPTH TOP OF SCREEN: \_\_\_\_\_

TYPE OF SCREEN: \_\_\_\_\_

TYPE OF SAND PACK: \_\_\_\_\_

ELEVATION / DEPTH BOTTOM OF SCREEN: \_\_\_\_\_


ELEVATION / DEPTH BOTTOM OF SAND PACK: \_\_\_\_\_

TYPE OF BACKFILL BELOW OBSERVATION WELL: \_\_\_\_\_

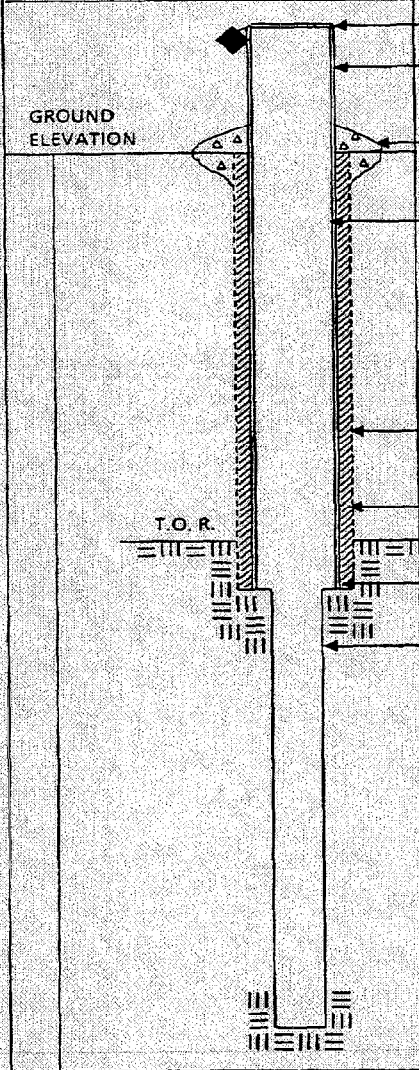
ELEVATION / DEPTH OF HOLE: \_\_\_\_\_

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**ATTACHMENT C-7**  
**EXAMPLE BEDROCK MONITORING WELL SHEET - OPEN HOLE WELL**


		<b>BEDROCK MONITORING WELL SHEET</b> <b>OPEN HOLE WELL</b>		BORING NO.: _____
		PROJECT _____ LOCATION _____ PROJECT NO. _____ BORING _____ ELEVATION _____ DATE _____ FIELD GEOLOGIST _____		DRILLER _____ DRILLING METHOD _____ DEVELOPMENT METHOD _____

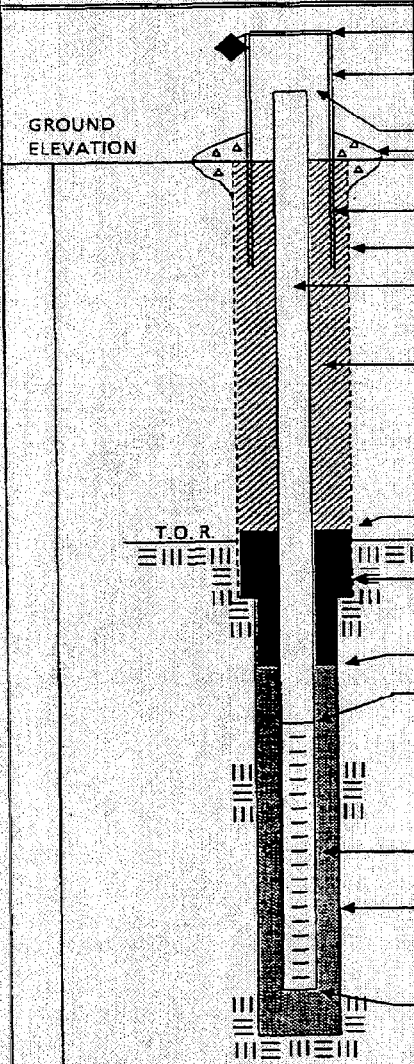
	ELEVATION OF TOP OF CASING: _____
	STICK UP OF CASING ABOVE GROUND SURFACE: _____
	TYPE OF SURFACE SEAL: _____
	I.D. OF CASING: _____
	TYPE OF CASING: _____
	TEMP. / PERM.: _____
	DIAMETER OF HOLE: _____
	TYPE OF CASING SEAL: _____
	DEPTH TO TOP OF ROCK: _____
	DEPTH TO BOTTOM CASING: _____
DIAMETER OF HOLE IN BEDROCK: _____	
DESCRIBE IF CORE / REAMED WITH BIT: _____	
DESCRIBE JOINTS IN BEDROCK AND DEPTH: _____	
ELEVATION / DEPTH OF HOLE: _____	

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**ATTACHMENT C-8**  
**EXAMPLE BEDROCK MONITORING WELL SHEET - WELL INSTALLED IN BEDROCK**

		<b>BEDROCK MONITORING WELL SHEET</b> <b>WELL INSTALLED IN BEDROCK</b>		BORING NO.: _____
PROJECT _____ PROJECT NO. _____ ELEVATION _____ FIELD GEOLOGIST _____		LOCATION _____ BORING _____ DATE _____		DRILLER _____ DRILLING METHOD _____ DEVELOPMENT METHOD _____


  

	ELEVATION OF TOP OF SURFACE CASING: _____ STICK UP OF CASING ABOVE GROUND SURFACE: _____ ELEVATION TOP OF RISER: _____ TYPE OF SURFACE SEAL: _____ I.D. OF SURFACE CASING: _____ DIAMETER OF HOLE: _____ RISER PIPE I.D.: _____ TYPE OF RISER PIPE: _____ TYPE OF BACKFILL: _____
	ELEVATION / DEPTH TOP OF SEAL: _____ ELEVATION / DEPTH TOP OF BEDROCK: _____ TYPE OF SEAL: _____
	ELEVATION / DEPTH TOP OF SAND: _____ ELEVATION / DEPTH TOP OF SCREEN: _____ TYPE OF SCREEN: _____ SLOT SIZE x LENGTH: _____ I.D. SCREEN: _____ TYPE OF SAND PACK: _____
	DIAMETER OF HOLE IN BEDROCK: _____ CORE / REAM: _____
	ELEVATION / DEPTH BOTTOM SCREEN: _____ ELEVATION / DEPTH BOTTOM OF HOLE: _____

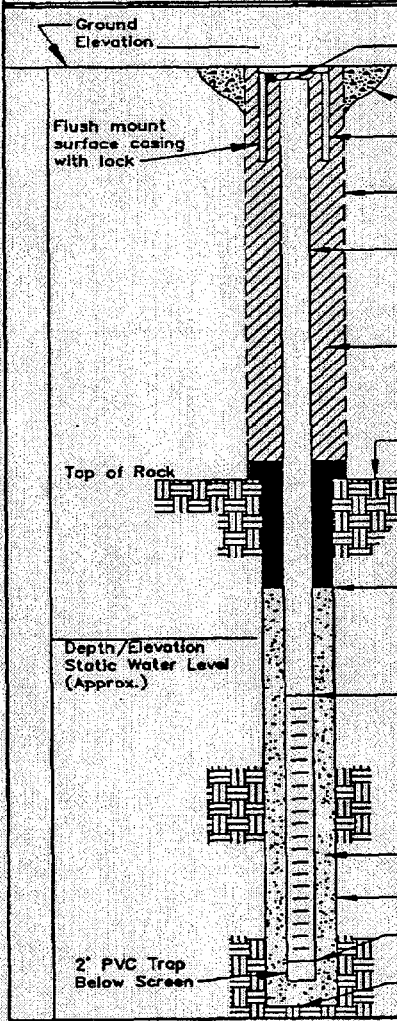


**ATTACHMENT C-9  
EXAMPLE BEDROCK MONITORING WELL SHEET  
WELL INSTALLED IN BEDROCK (FLUSHMOUNT)**

BORING NO.: \_\_\_\_\_


**BEDROCK  
MONITORING WELL SHEET  
WELL INSTALLED IN BEDROCK**

PROJECT: _____	LOCATION: _____	DRILLER: _____
PROJECT NO.: _____	BORING: _____	DRILLING METHOD: _____
ELEVATION: _____	DATE: _____	DEVELOPMENT METHOD: _____
FIELD GEOLOGIST: _____		



ELEVATION TOP OF RISER: \_\_\_\_\_

TYPE OF SURFACE SEAL: \_\_\_\_\_

TYPE OF PROTECTIVE CASING: \_\_\_\_\_

I.D. OF PROTECTIVE CASING: \_\_\_\_\_

DIAMETER OF HOLE: \_\_\_\_\_

TYPE OF RISER PIPE: \_\_\_\_\_

RISER PIPE I.D.: \_\_\_\_\_

TYPE OF BACKFILL/SEAL: \_\_\_\_\_

DEPTH/ELEVATION TOP OF BEDROCK: \_\_\_\_\_ / \_\_\_\_\_

DEPTH/ELEVATION TOP OF SAND: \_\_\_\_\_ / \_\_\_\_\_

DEPTH/ELEVATION TOP OF SCREEN: \_\_\_\_\_ / \_\_\_\_\_

TYPE OF SCREEN: \_\_\_\_\_

SLOT SIZE x LENGTH: \_\_\_\_\_

TYPE OF SAND PACK: \_\_\_\_\_

DIAMETER OF HOLE IN BEDROCK: \_\_\_\_\_

DEPTH/ELEVATION BOTTOM OF SCREEN: \_\_\_\_\_ / \_\_\_\_\_

DEPTH/ELEVATION BOTTOM OF SAND: \_\_\_\_\_ / \_\_\_\_\_

DEPTH/ELEVATION BOTTOM OF HOLE: \_\_\_\_\_ / \_\_\_\_\_

BACKFILL MATERIAL BELOW SAND: \_\_\_\_\_

ACFILE: 16701/DEAL/BEED1.DWG



Subject

## FIELD DOCUMENTATION

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SA-6.3

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1

Effective Date

01/00

## ATTACHMENT C-11

## EXAMPLE CERTIFICATE OF CONFORMANCE

MONITORING WELL MATERIALS  
CERTIFICATE OF CONFORMANCE

Well Designation: \_\_\_\_\_

Site Name: \_\_\_\_\_

Date Installed: \_\_\_\_\_

Project Name: \_\_\_\_\_

Site Geologist: \_\_\_\_\_

Drilling Company: \_\_\_\_\_

Driller: \_\_\_\_\_

Project Number: \_\_\_\_\_

Material	Brand/Description	Source/Supplier	Sample Collected ?
Well Casing			
Well Screen			
End Cap			
Drilling Fluid			
Drilling Fluid Additives			
Backfill Material			
Annular Filter Pack			
Bentonite Seal			
Annular Grout			
Surface Cement			
Protective Casing			
Paint			
Rod Lubricant			
Compressor Oil			

To the best of my knowledge, I certify that the above described materials were used during installation of this monitoring well.

Signature of Site Geologist: \_\_\_\_\_

**ATTACHMENT C-12**



# MONITORING WELL DEVELOPMENT RECORD

Page \_\_\_\_ of \_\_\_\_

Site: \_\_\_\_\_ Depth to Bottom (ft.): \_\_\_\_\_ Project Name: \_\_\_\_\_  
Well: \_\_\_\_\_ Static Water Level Before (ft.): \_\_\_\_\_ Project Number: \_\_\_\_\_  
Date Installed: \_\_\_\_\_ Static Water Level After (ft.): \_\_\_\_\_ Site Geologist: \_\_\_\_\_  
Date Developed: \_\_\_\_\_ Screen Length (ft.): \_\_\_\_\_ Drilling Co.: \_\_\_\_\_  
Dev. Method: \_\_\_\_\_ Specific Capacity: \_\_\_\_\_  
Pump Type: \_\_\_\_\_ Casing ID (in.): \_\_\_\_\_

019611/P



Effective Date  
01/00

**ATTACHMENT D**



**Tetra Tech NUS, Inc.**



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**ATTACHMENT F  
FIELD TRIP SUMMARY REPORT  
PAGE 1 OF 2**

**SUNDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_  
Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**MONDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_  
Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**TUESDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_  
Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**WEDNESDAY**

Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_  
Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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**ATTACHMENT F**  
**PAGE 2 OF 2**  
**FIELD TRIP SUMMARY REPORT**

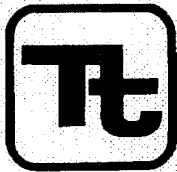
**THURSDAY**  
Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_  
  
Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**FRIDAY**  
Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_  
  
Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**SATURDAY**  
Date: \_\_\_\_\_ Personnel: \_\_\_\_\_  
Weather: \_\_\_\_\_ Onsite: \_\_\_\_\_  
  
Site Activities: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



**TETRA TECH NUS, INC.**

# STANDARD OPERATING PROCEDURES

Number  
SA-7.1

Page  
1 of 8

Effective Date  
09/03

Revision  
3

Applicability  
Tetra Tech NUS, Inc.

Prepared  
Earth Sciences Department

Subject DECONTAMINATION OF FIELD EQUIPMENT

Approved  
D. Senovich

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## 1.0 PURPOSE

Decontamination is the process of removing and/or neutralizing site contaminants that have contacted and/or accumulated on equipment. The objective/purpose of this SOP is intended to protect site personnel, general public, and the sample integrity through the prevention of cross contamination onto unaffected persons or areas. It is further intended through this procedure to provide guidelines regarding the appropriate procedures to be followed when decontaminating drilling equipment, monitoring well materials, chemical sampling equipment and field analytical equipment.

## 2.0 SCOPE

This procedure applies to all equipment including drilling equipment, heavy equipment, monitoring well materials, as well as chemical sampling and field analytical equipment decontamination that may be used to provide access/acquire environmental samples. Where technologically and economically feasible, single use sealed disposable equipment will be employed to minimize the potential for cross contamination. This procedure also provides general reference information on the control of contaminated materials.

## 3.0 GLOSSARY

Acid - For decontamination of equipment when sampling for trace levels of inorganics, a 10% solution of nitric acid in deionized water should be used. Due to the leaching ability of nitric acid, it should not be used on stainless steel.

Alconox/Liquinox - A brand of phosphate-free laboratory-grade detergent.

Decontamination Solution - Is a solution selected/identified within the Health and Safety Plan or Project-Specific Quality Assurance Plan. The solution is selected and employed as directed by the project chemist/health and safety professional.

Deionized Water (DI) - Deionized water is tap water that has been treated by passing through a standard deionizing resin column. This water may also pass through additional filtering media to attain various levels of analyte-free status. The DI water should meet CAP and NCCLS specifications for reagent grade, Type I water.

Potable Water - Tap water used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

Pressure Washing - Employs high pressure pumps and nozzle configuration to create a high pressure spray of potable water. High pressure spray is employed to remove solids.

Solvent - The solvent of choice is pesticide-grade Isopropanol. Use of other solvents (methanol, acetone, pesticide-grade hexane, or petroleum ether) may be required for particular projects or for a particular purpose (e.g. for the removal of concentrated waste) and must be justified in the project planning documents. As an example, it may be necessary to use hexane when analyzing for trace levels of pesticides, PCBs, or fuels. In addition, because many of these solvents are not miscible in water, the equipment should be air dried prior to use. Solvents should not be used on PVC equipment or well construction materials.

Steam Pressure Washing - This method employs a high pressure spray of heated potable water. This method through the application of heat provides for the removal of various organic/inorganic compounds.

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#### 4.0 RESPONSIBILITIES

Project Manager - Responsible for ensuring that all field activities are conducted in accordance with approved project plan(s) requirements.

Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved Standards Operating Procedures or as otherwise dictated by the approved project plan(s).

Site Health and Safety Officer (SHSO) - The SHSO exercises shared responsibility with the FOL concerning decontamination effectiveness. All equipment arriving on-site (as part of the equipment inspection), leaving the site, moving between locations are required to go through a decontamination evaluation. This is accomplished through visual examination and/or instrument screening to determine the effectiveness of the decontamination process. Failure to meet these objectives are sufficient to restrict equipment from entering the site/exiting the site/ or moving to a new location on the site until the objectives are successfully completed.

#### 5.0 PROCEDURES

The process of decontamination is accomplished through the removal of contaminants, neutralization of contaminants, or the isolation of contaminants. In order to accomplish this activity a level of preparation is required. This includes site preparation, equipment selection, and evaluation of the process. Site contaminant types, concentrations, media types, are primary drivers in the selection of the types of decontamination as well as where it will be conducted. For purposes of this SOP discussion will be provided concerning general environmental investigation procedures.

The decontamination processes are typically employed at:

- Temporary Decontamination Pads/Facilities
- Sample Locations
- Centralized Decontamination Pad/Facilities
- Combination of some or all of the above

The following discussion represents recommended site preparation in support of the decontamination process.

##### 5.1 Decontamination Design/Constructions Considerations

##### 5.1.1 Temporary Decontamination Pads

Temporary decontamination pads are constructed at satellite locations in support of temporary work sites. These structures are generally constructed to support the decontamination of heavy equipment such as drill rigs and earth moving equipment but can be employed for smaller articles.

The purpose of the decontamination pad is to contain wash waters and potentially contaminated soils generated during decontamination procedures. Therefore, construction of these pads should take into account the following considerations



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- Site Location – The site selected should be within a reasonable distance from the work site but should avoid:
  - Pedestrian/Vehicle thoroughfares
  - Areas where control/custody cannot be maintained
  - Areas where a potential releases may be compounded through access to storm water transport systems, streams or other potentially sensitive areas.
  - Areas potentially contaminated.
- Pad – The pad should be constructed to provide the following characteristics
  - Size – The size of the pad should be sufficient to accept the equipment to be decontaminated as well as permitting free movement around the equipment by the personnel conducting the decontamination.
  - Slope – An adequate slope will be constructed to permit the collection of the water and potentially contaminated soils within a trough or sump constructed at one end. The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks.
  - Sidewalls – The sidewalls should be a minimum of 6-inches in height to provide adequate containment for wash waters and soils. If splash represents a potential problem, splash guards should be constructed to control overspray. Sidewalls maybe constructed of wood, inflatables, sand bags, etc. to permit containment.
  - Liner – Depending on the types of equipment and the decontamination method the liner should be of sufficient thickness to provide a puncture resistant barrier between the decontamination operation and the unprotected environment. Care should be taken to examine the surface area prior to placing the liner to remove sharp articles (sticks, stones, debris) that could puncture the liner. Liners are intended to form an impermeable barrier. The thickness may vary from a minimum recommended thickness of 10 mil to 30 mil. Achieving the desired thickness maybe achieved through layering lighter constructed materials. It should be noted that various materials (rubber, polyethylene sheeting) become slippery when wet. To minimize this potential hazard associated with a sloped liner a light coating of sand maybe applied to provide traction as necessary.
  - Wash/drying Racks – Auger flights, drill/drive rods require racks positioned off of the ground to permit these articles to be washed, drained, and dried while secured from falling during this process. A minimum ground clearance of 2-feet is recommended.
  - Maintenance – The work area should be periodically cleared of standing water, soils, and debris. This action will aid in eliminating slip, trip, and fall hazards. In addition, these articles will reduce potential backsplash and cross contamination. Hoses should be gathered when not in use to eliminate potential tripping hazards.

#### **5.1.2 Decontamination Activities at Drill Rigs/DPT Units**

During subsurface sampling activities including drilling and direct push activities decontamination of drive rods, Macro Core Samplers, split spoons, etc. are typically conducted at an area adjacent to the operation. Decontamination is generally accomplished using a soap/water wash and rinse utilizing buckets and brushes. This area requires sufficient preparation to accomplish the decontamination objectives.

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Buckets shall be placed within mortar tubs or similar secondary containment tubs to prevent splash and spills from reaching unprotected media. Drying racks will be employed as directed for temporary pads to permit parts to dry and be evaluated prior to use/re-use.

### 5.1.3 Decontamination Activities at Remote Sample Locations

When sampling at remote locations sampling devices such as trowels, pumps/tubing should be evacuated of potentially contaminated media to the extent possible. This equipment should be wrapped in plastic for transport to the temporary/centralized decontamination location for final cleaning and disposition.

## 5.2 Equipment Decontamination Procedures

The following represents procedures to be employed for the decontamination of equipment that may have contacted and/or accumulated contamination through site investigation activities.

### 5.2.1 Monitoring Well Sampling Equipment

#### 5.2.1.1 Groundwater sampling pumps – This includes pumps inserted into the monitoring well such as Bladder pumps, Whale pumps, Redi-Flo, reusable bailers, etc.

- 1) Evacuate to the extent possible, any purge water within the pump.
- 2) Scrub using soap and water and/or steam clean the outside of the pump and tubing, where applicable.
- 3) Insert the pump and tubing into a clean container of soapy water. Pump a sufficient amount of soapy water through the pump to flush any residual purge water. Once flushed, circulate soapy water through the pump to ensure the internal components are thoroughly flushed.
- 4) Remove the pump and tubing from the container, rinse external components using tap water. Insert the pump and tubing into a clean container of tap water. Pump a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).
- 5) Rinse equipment with pesticide grade isopropanol
- 6) Repeat item #4 using deionized water through the hose to flush out the tap water and solvent residue as applicable.
- 7) Drain residual deionized water to the extent possible, allow components to air dry.
- 8) Wrap pump in aluminum foil or a clear clean plastic bag for storage.

#### 5.2.1.2 Electronic Water Level Indicators/Sounders/Tapes

During water level measurements, rinsing with the extracted tape and probe with deionized water and wiping the surface of the extracted tape is acceptable. However, periodic full decontamination should be conducted as indicated below.

- The solvent should be employed when samples contain oil, grease, PAHs, PCBs, and other hard to remove materials. If these are not of primary concern, the solvent step may be omitted. In addition, do not rinse PE, PVC, and associated tubing with solvents.

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- 1) Wash with soap and water
- 2) Rinse with tap water
- 3) Rinse with deionized water

**Note:** In situations where oil, grease, free product, other hard to remove materials are encountered probes and exposed tapes should be washed in hot soapy water.

#### 5.2.1.3 Miscellaneous Equipment

Miscellaneous equipment including analytical equipment (water quality testing equipment) should be cleaned per manufacturer's instructions. This generally includes wiping down the sensor housing and rinsing with tap and deionized water.

Coolers/Shipping Containers employed to ship samples are received from the lab in a variety of conditions from marginal to extremely poor. Coolers should be evaluated prior to use for

- Structural integrity – Coolers missing handles or having breaks within the outer housing should be removed and not used. Notify the laboratory that the risk of shipping samples will not be attempted and request a replacement unit.
- Cleanliness – As per protocol only volatile organic samples are accompanied by a trip blank. If a cooler's cleanliness is in question (visibly dirty/stained) or associated with noticeable odors it should be decontaminated prior to use.

- 1) Wash with soap and water
- 2) Rinse with tap water
- 3) Dry

If these measures fail to clean the cooler to an acceptable level, remove the unit from use as a shipping container and notify the laboratory to provide a replacement unit.

#### 5.2.2 **Down-Hole Drilling Equipment**

This includes any portion of the drill rig that is over the borehole including auger flights, drill stems, rods, and associated tooling that would extend over the borehole. This procedure is to be employed prior to initiating the drilling/sampling activity, then between locations.

- 1) Remove all soils to the extent possible using shovels, scrapers, etc. to remove loose soils.
- 2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.
- 3) Rinse with tap water.
- 4) Rinse equipment with pesticide grade isopropanol
- 5) To the extent possible allow components to air dry.
- 6) Wrap or cover equipment in clear plastic until it is time to be used.

#### 5.2.3 **Soil/Sediment Sampling Equipment**

This consists of soil sampling equipment including but not limited to hand augers, stainless steel trowels/spoons, bowls, dredges, scoops, split spoons, Macro Core samplers, etc.

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- 1) Remove all soils to the extent possible.
- 2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.
- 3) Rinse with tap water.
- 4) Rinse equipment with pesticide grade isopropanol
- 5) Rinse with deionized water
- 6) To the extent possible allow components to air dry.
- 7) If the device is to be used immediately, screen with a PID/FID to insure all solvents (if they were used) and trace contaminants have been adequately removed.
- 8) Once these devices have been dried wrap in aluminum foil for storage until it is time to be used.

**5.3            Contact Waste/Materials**

During the course of field investigations disposable/single use equipment becomes contaminated. These items include tubing, trowels, PPE (gloves, overboots, splash suits, etc.) broken sample containers.

With the exception of the broken glass, single use articles should be cleaned (washed and rinsed) of visible materials and disposed of as normal refuse. The exception to this rule is that extremely soiled materials that cannot be cleaned should be containerized for disposal in accordance with applicable federal state and local regulations.

**5.3.1            Decontamination Solutions**

All waste decontamination solutions and rinses must be assumed to contain the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. The waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility. These containers must be appropriately labeled.

**5.4            Decontamination Evaluation**

Determining the effectiveness of the decontamination process will be accomplished in the following manner

- Visual Evaluation – A visual evaluation will be conducted to insure the removal of particulate matter. This will be done to insure that the washing/rinsing process is working as intended.
- Instrument Screening – A PID and/or an FID should be used to evaluate the presence of the contaminants or solvents used in the cleaning process. The air intake of the instrument should be passed over the article to be evaluated. A positive detection requires a repeat the decontamination process. It should be noted that the instrument scan is only viable if the contaminants are detectable within the instruments capabilities.

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- Rinsate Blanks – It is recommended that Rinsate samples be collected to
  - Evaluate the decontamination procedure representing different equipment applications (pumps versus drilling equipment) and different decontamination applications.
  - Single use disposable equipment – The number of samples should represent different types of equipment as well as different Lot Numbers of single use articles.

The collection and the frequency of collection of rinsate samples are as follows:

- Per decontamination method
- Per disposable article/Batch number of disposable articles

It is recommended that an initial rinsate sample be collected early in the project to ensure that the decontamination process is functioning properly and in an effort to avoid using a contaminated batch of single use articles. It is recommended that a follow up sample be collected during the execution of the project to insure those conditions do not change. Lastly, rinsate samples collection may be driven by types of and/or contaminant levels. Hard to remove contaminants, oils/greases, some PAHs/PCBs, etc. may also support the collection of additional rinsates due to the obvious challenges to the decontamination process. This is a field consideration to be determined by the FOL.

**APPENDIX B**  
**FIELD FORMS**

## SAMPLE LOG SHEET - SOLID PHASE

Tetra Tech NUS Charge No. \_\_\_\_\_  
QC Information: \_\_\_\_\_ (if applicable)

TYPE OF SAMPLE: (Check all that apply)

_____ Soil	_____ Trip Blank*
_____ Sediment	_____ Rinsate Blank*
_____ Lagoon/Pond	_____ Field Duplicate collected
_____ Grab	_____ Other (Specify): _____

Description: (Sand, Clay, Muck, Peat, Dry, Moist, Wet, Etc.)

PID/OVA Monitor Reading: \_\_\_\_\_ ppm

SAMPLE DATA/REMARKS: \_\_\_\_\_

[illegible]





TETRA TECH NUS, INC.

## SAMPLE LOG SHEET - LIQUID PHASE

Site Name: \_\_\_\_\_  
Sample ID: \_\_\_\_\_Tetra Tech NUS Charge No. \_\_\_\_\_  
QC Information: \_\_\_\_\_ (if applicable)Sample Method/Device: \_\_\_\_\_  
Depth Sampled: \_\_\_\_\_ feet Total Depth \_\_\_\_\_ feet (SW Only)  
Sample Date & Time: \_\_\_\_/\_\_\_\_/\_\_\_\_ hours  
Sampler(s): \_\_\_\_\_Recorded By: \_\_\_\_\_  
Signature

## TYPE OF SAMPLE: (Check all that apply)

☐ Groundwater  
☐ Surface Water  
☐ Residential Supply  
☐ Grab  
☐ Composite☐ Trip Blank\*  
☐ Rinsate Blank\*  
☐ Field Duplicate Collected  
☐ Other (Specify): \_\_\_\_\_

\* include sample source &amp; lot No.

## WELL PURGE DATA:

Well Depth	feet	Purge Start	hrs
Inside Diameter	Inches	Purge Stop Time	hrs
Water Level	feet	Total Gallons Purged	
Well Volume	gal.	Purge Method	

## Sampling/Purge Data:

Vol. #	Temp °C	pH	Spec. Cond.	DO
0	_____	_____	_____	_____
1	_____	_____	_____	_____
3	_____	_____	_____	_____
4	_____	_____	_____	_____

Color: \_\_\_\_\_ Turbidity: CLR/SL CLDY/CLDY/OPAQ

ANALYSIS	BOTTLE LOT NO.	TRAFFIC REPORT NO.		COMMENTS
		ORGANIC	INORGANIC	



## SITE INFORMATION

Site Name: \_\_\_\_\_ Municipality: \_\_\_\_\_  
Project Number: \_\_\_\_\_ County: \_\_\_\_\_  
Personnel: \_\_\_\_\_ State: \_\_\_\_\_  
Date: \_\_\_\_\_ Street or Map Location: \_\_\_\_\_  
(If Off-Site): \_\_\_\_\_

## WEATHER CONDITIONS AND EQUIPMENT

Temperature Range: \_\_\_\_\_ Equipment No.: \_\_\_\_\_  
Precipitation: \_\_\_\_\_ Equipment Number: \_\_\_\_\_  
Barometric Pressure: \_\_\_\_\_ Latest Calibration Date: \_\_\_\_\_  
Tidally-Influenced ☐ Yes ☐ No

Well or Piezometer Number	Date/Time	Elevation of Reference Point (Feet)*	Water Level Indicator Reading (Feet)*	Adjusted Depth (Feet)*	Groundwater Elevation (Feet)*



TETRA TECH NUS, INC.

WELL INSPECTION AND GROUNDWATER LEVEL  
MEASUREMENT SHEET

WELL NUMBER: \_\_\_\_\_

PROJECT NAME: \_\_\_\_\_

DATE/TIME: \_\_\_\_\_

PROJECT MANAGER: \_\_\_\_\_

INSPECTED BY: \_\_\_\_\_

VENT WELL

MONITORING INSTRUMENT READING: \_\_\_\_\_

LEL/O2 READING: \_\_\_\_\_

WELL INSPECTION/GROUNDWATER LEVEL MEASUREMENT

WELL DEPTH (FEET FROM TOP OF PVC) \_\_\_\_\_

WATER LEVEL DEPTH (FEET FROM TOP OF PVC) \_\_\_\_\_

WELL STICK-UP \_\_\_\_\_

CASING STICK-UP (FEET) \_\_\_\_\_

WELL DIAMETER (INCHES) \_\_\_\_\_

WELL CONSTRUCTION (PVC, STEEL, ETC.) \_\_\_\_\_

LOCKED UPON ARRIVAL? YES NO

LOCKED REPLACED? YES NO

OBSTRUCTIONS? YES NO

WELL RELABELED? YES NO

SLUG TEST CONDUCTED? YES NO (If YES, refer to "Hydraulic  
Conductivity Testing Data  
Sheet")

GENERAL CONDITION/COMMENTS: \_\_\_\_\_



# WELL DEVELOPMENT DATA SHEET

Well No.: \_\_\_\_\_

PROJECT: \_\_\_\_\_

DATE: \_\_\_\_\_

PROJECT NO.: \_\_\_\_\_

WEATHER: \_\_\_\_\_

PERSONNEL: \_\_\_\_\_

Well Screen Depth: \_\_\_\_\_ / \_\_\_\_\_ ft. bgs

Pump Type/Material: \_\_\_\_\_

Total Purge Volume = \_\_\_\_\_ (gal)

H&amp;S Monitoring Instrument Reading \_\_\_\_\_

Pump Intake Depth: \_\_\_\_\_

Data Recorded By: \_\_\_\_\_



TETRA TECH NUS, INC.

## RECORD OF FIELD WORK ORIENTATION

Page \_\_\_\_ of \_\_\_\_

SITE: \_\_\_\_\_

JOB NO.: \_\_\_\_\_

WORK ASSIGNMENT NO.: \_\_\_\_\_

TASK OR ACTIVITY: \_\_\_\_\_

DATE OF ORIENTATION: \_\_\_\_\_

<u>PERSONNEL ATTENDING</u> <u>MGR.</u>	<u>TRAINERS</u>	<u>FOL</u>	<u>PROJECT</u>
---	-----------------	------------	----------------

1.	1.	1.	1.
2.	2.		
3.	3.		
4.			
5.			
6.			
7.			

## VERIFICATIONS (CHECK AND INITIAL BY ATTENDEES)

WORK PLAN REVIEWED	SAP/QAPP REVIEWED	SOGs REVIEWED	SITE/EQUIP. SECURITY REVIEWED	EQUIPMENT OPERATION	H&S PLAN REVIEWED	PURCHASING	INITIALS
1. _____	_____	_____	_____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____	_____	_____	_____
5. _____	_____	_____	_____	_____	_____	_____	_____
6. _____	_____	_____	_____	_____	_____	_____	_____
7. _____	_____	_____	_____	_____	_____	_____	_____

RETURN ORIGINAL TO THE QUALITY ASSURANCE OFFICER

Copies to: PROJECT FILE: \_\_\_\_\_

PROJECT MANAGER: \_\_\_\_\_

PROGRAM MANAGER: \_\_\_\_\_



TETRA TECH NUS, INC.

## YSI 6820 MULTIPARAMETER METER

Serial No.: \_\_\_\_\_ Model No.: \_\_\_\_\_ Decal No.: \_\_\_\_\_

Site Name: \_\_\_\_\_ Job No.: \_\_\_\_\_

Instrument is calibrated in accordance with Manufacturer's Instructions

DATE:	Pre Calibration Readings	Post Calibration Readings	PM Check	Calibration STDs (lot #'s)	Signature	Remarks
Cond. mS/cm						
pH = 4.0						
pH = 7.0						
pH = 10.0						
D.O. mg/l						
REDOX mV						
Turbidity 0 NTUs						
Turbidity 100 NTUs						
Temp °C						
Salinity 0/00						

DATE:						
Cond. mS/cm						
pH = 4.0						
pH = 7.0						
pH = 10.0						
D.O. mg/l						
REDOX mV						
Turbidity 0 NTUs						
Turbidity 100 NTUs						
Temp °C						
Salinity 0/00						



Instrument is calibrated in accordance with Manufacturer's Instructions

Serial No.: \_\_\_\_\_ Model No.: \_\_\_\_\_ Decal No.: \_\_\_\_\_

Site Name: \_\_\_\_\_ Job No.: \_\_\_\_\_ Buffer Lot No.: \_\_\_\_\_

[illegible]





TETRA TECH NUS. INC.

## FIELD INSTRUMENT CALIBRATION LOG

INSTRUMENT NAME: \_\_\_\_\_

MODEL No.: \_\_\_\_\_

SERIAL No.: \_\_\_\_\_

DECAL No.: \_\_\_\_\_

TETRA TECH NUS CHARGE No. \_\_\_\_\_

CALIBRATION DATE	INITIAL READING	PROCEDURE	FINAL READING	SIGNATURE	COMMENTS



TETRA TECH NUS INC.

## FIELD MODIFICATION RECORD

Site Name: \_\_\_\_\_ Location: \_\_\_\_\_

Project Number: \_\_\_\_\_ Task Assignment: \_\_\_\_\_

To: \_\_\_\_\_ Location: \_\_\_\_\_ Date: \_\_\_\_\_

Description: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Reason for Change: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Recommended Action: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Field Operations Leader (Signature): \_\_\_\_\_ Date: \_\_\_\_\_

Disposition/Action: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Project Manager (Signature): \_\_\_\_\_ Date: \_\_\_\_\_

Distribution: Program Manager: \_\_\_\_\_  
Project Manager: \_\_\_\_\_  
Quality Assurance Officer: \_\_\_\_\_  
Field Operations Leader: \_\_\_\_\_  
Project File: \_\_\_\_\_

Others as Required: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



TETRA TECH NUS, INC.

## ***SITE ENTRY LOG***

Site Name: \_\_\_\_\_

Date: \_\_\_\_\_

Location: \_\_\_\_\_

Project Number \_\_\_\_\_

NAME	REPRESENTING	TIME IN (HOURS)	TIME OUT (HOURS)	INITIALS